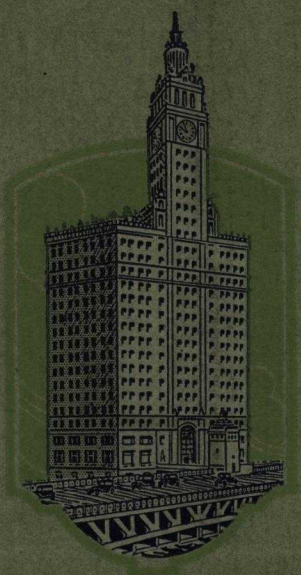
NATCO

STANDARD FIREPROOFING



BULLETIN NO. 171

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NATCO

STANDARD FIREPROOFING

BULLETIN No. 171

14th EDITION

NATIONAL FIRE PROOFING COMPANY

GENERAL OFFICES

FULTON BUILDING, PITTSBURGH, PA.

BRANCHES:

NEW YORK	PHILADELPHIA	BOSTON	CHICAGO
Flatiron Building	Land Title Building	Textile Building	26th and Shields Avenue

NATIONAL FIREPROOFING COMPANY OF CANADA, LTD.

TORONTO, ONTARIO

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2nd. Lightness. Weights of NATCO fireproofing are given under the various subjects of the text, and these should be contrasted with the much heavier solid masonry weights of brick, 120 lb. per cu. ft.; cinder concrete, 110 lb. per cu. ft.; stone concrete, 144 lb. per cu. ft. Using the lighter hollow tile in floors and walls permits of a lighter structural frame and greatest economy in design.

3rd. Soundproofness. On account of the still air spaces in hollow tile construction, it is more nearly soundproof and far better from an insulation standpoint than any solid structural material.

4th. Permanence. Structural steel work must be preserved from corrosion. Portland cement mortar which is used in setting NATCO tile is the best rust preventative known. Hollow tile is not affected by water or acids. All cinder concretes contain ingredients injurious to steel. In some cases the deterioration from these causes is very rapid.

5th. Service. Our engineers are always glad to co-operate with those who are interested in the design and construction of fire-resistive buildings and estimates of the cost of the work will be cheerfully given.

6th. Distribution. NATCO factories are located near all the great centers of population. We have, therefore, better facilities for the manufacture and delivery of hollow tile fireproofing than other manufacturers.

Promptness in delivery of material is vital where buildings must be erected on schedule time. *Delay of a few weeks often means the loss of rental for an entire year.*

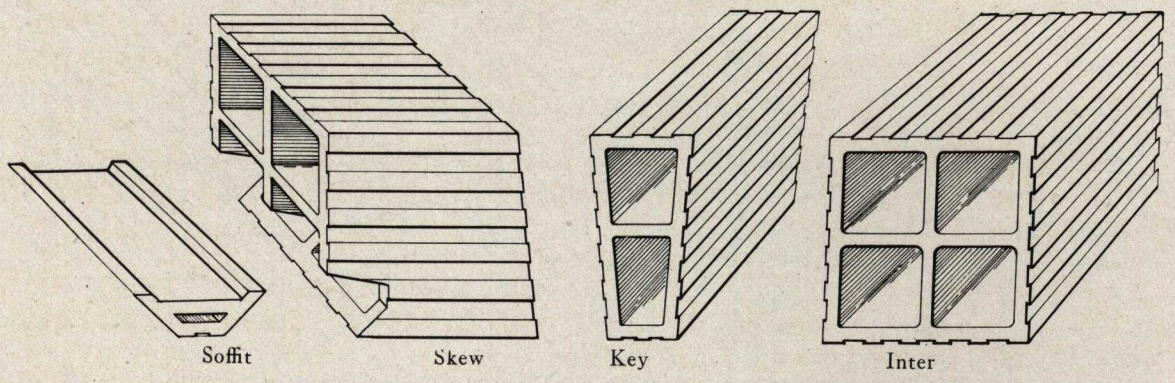
NATCO Hollow tile is made from good refractory clay and is a uniformly hard burned material.

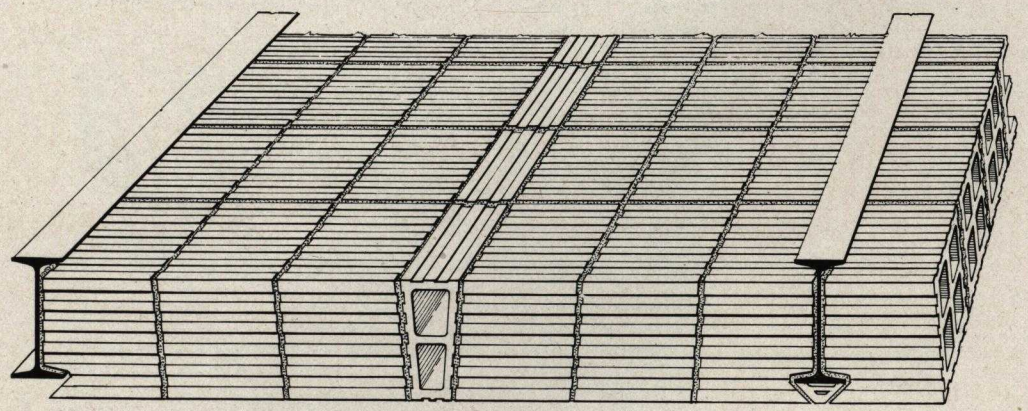
The methods illustrated and described represent the work as approved by engineers and architects, having been determined by wide, practical experience in NATCO Hollow Tile construction. Local building code requirements should, of course, always be taken into consideration.

The constantly increasing number of buildings all over the country which have been fireproofed with NATCO Hollow Tile is ample testimony of the high position it holds in the estimation of leading architects and engineers.

We shall be glad at all times to give additional or special information regarding NATCO Hollow Tile and its different uses in building construction to any interested party.

NATCO FLAT ARCH
END CONSTRUCTION





Typical Span—End Construction Flat Arch

FLAT arches as adapted to floors and roofs are made up of various shaped tile, as shown in the drawing above and on page 6. The tile resting against the beams are called "skews" and the protection for the beam known as the "soffit" tile is held in place by the bevel on the "skews." The intermediate tile are called "inters," and the center one the "key."

There is shown above a typical section illustrating the method of assembling the various members of the arch. The depth of the arch must be proportioned to the span between the beams and to a certain extent to the load to be carried. Safe loads for various spans are given in table on page 7.

A safe general rule for finding the proper depth of the arch in inches is to multiply the spans in feet by 1½ in. and add the thickness of the protection below the beams. This is the code requirements of the larger cities in general. Outside shells and interior webs should be not less than ⅝ in. and ½ in. thick, respectively, and all exposed beams covered by 2 in. of material.

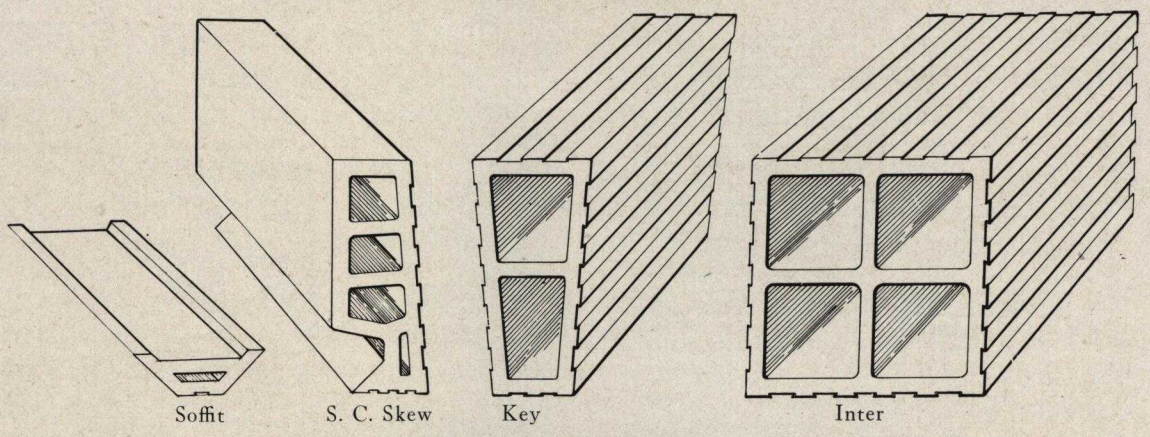
The arch tile must be set end to end in straight courses from beam to beam, except for the keys which are usually side construction as shown above. The tile are cut to a proper bevel; the tighter they are set the stronger the arch.

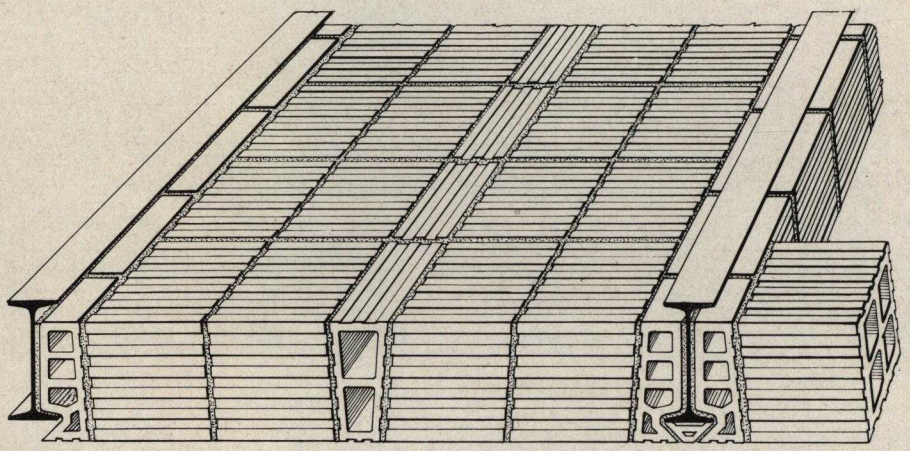
In arches of this type the skews ordinarily furnished are 12 in. long, the inters 12 in. and 8 in., and the keys 3 in., 4 in., 5 in., and 6 in.

If wooden flooring is used over the arches the space between the sleepers up to the underside of the flooring should be filled with concrete, made of broken tile or cinders, sand and cement as shown in typical sections on page 8. Under no circumstances should this space be left open for the free circulation of fire.

NATCO FLAT ARCH

COMBINATION END AND SIDE CONSTRUCTION

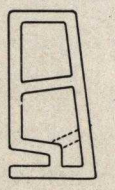




Typical Span—Combination of End and Side Construction Flat Arch

WE recommend the use of heavy side construction skews and keys with the end construction inters as shown above. By reversing thus the direction of the cells in the skews, better protection is given to the sides of the beams by the mortar joints and by the shells of the skews. The "inters" must be set end to end in straight courses from skew to key. The typical section shown above illustrates the method of assembling the various members of the arch.

The depth of the arch must be proportioned to the span between the beams and to a certain extent to the load to be carried. Safe loads for various spans are given in table and example on next page for both types of flat arch construction.



The line of greatest pressure in a flat arch is near the top of the key and the bottom of the skewback. Note faulty construction of skew shown. It should have member shown in dotted lines to oppose the thrust near the bottom. This is of the utmost importance, but is frequently omitted in the endeavor to reduce weight. Arches have collapsed from this cause alone.

Where a paneled ceiling effect can be permitted, the dead weight of cinder fill over the arches can be frequently reduced by using raised skewbacks, thus raising the top of the arch level with top of beams. Where head room is the great consideration and no great heat possible in case of fire, plain skewbacks (without the beam protection) may be used, but not otherwise.

In arches of this type the skews ordinarily furnished are 4½ in. wide, the inters 12 in. and 8 in., and the keys 3 in., 4 in., 5 in. and 6 in.

NATCO FLAT ARCH
DATA FOR DESIGNING PURPOSES

THE following table is applicable to all shapes of tile. Generally speaking, hollow tile of various shapes but of the same depth and cross-sectional area, have equal strength, and therefore, the strengths of arches of equal depth are directly proportional to their net sectional areas.

The strength of any arch depends as largely upon the workmanship as upon the material. The spans given in the table are safe if the arches are properly set, but may not agree with the requirements of the Building Codes of various cities.

Safe Loads given in the table have been figured for the Natco Combination Arch of side construction skews and keys with end construction inters. The net sectional areas of tile indicated, are for the keys—the critical point of the arch—and are taken per foot of tile parallel to beams.

Weights of arches have NOT been deducted from safe loads in the table; this and other dead load must be deducted to obtain the net safe live load for any arch and span.

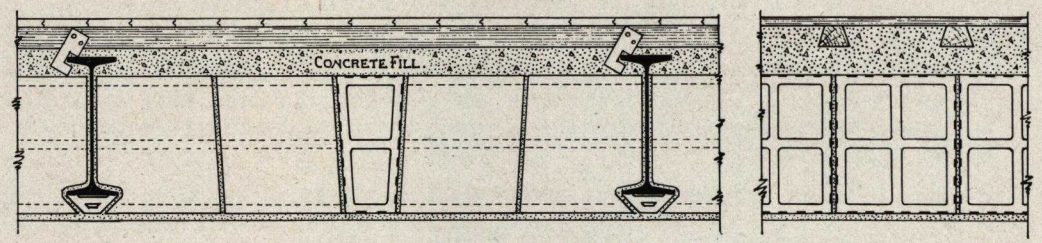
TABLE OF SAFE LOADS PER SQ. FT.

(Dead and Live)

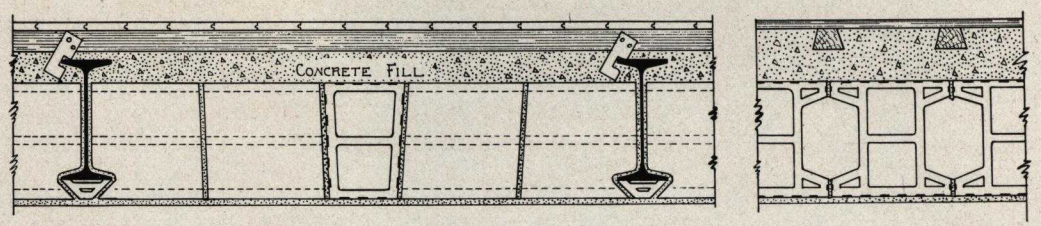
FACTOR OF SAFETY OF 7

Arches	6 in.	7 in.	8 in.	9 in	10 in.	12 in.	15 in.
Net Sectional Areas	27 sq. in.	27 sq. in.	27 sq. in.	27 sq. in.	36 sq. in.	36 sq. in.	36 sq. in.
Average Wt. per sq. ft.	26 lb.	30 lb.	32 lb.	36 lb.	40 lb.	48 lb.	56 lb.
Span—ft. and in.	lb.	lb.	lb.	lb.	lb.	lb.	lb.
3–0	420	490	560	630	933	1120	1400
3–3	357	417	477	537	795	954	1193
3–6	308	360	411	462	685	823	1028
3–9	268	313	358	403	597	716	895
4–0	236	276	315	354	525	630	786
4–3	.....	244	279	314	465	558	697
4–6	.....	218	249	279	415	497	622
4–9	.....	.....	223	251	372	447	558
5–0	.....	.....	201	227	336	402	504
5–3	.....	.....	182	205	305	365	457
5–6	.....	.....	.....	187	277	333	417
5–9	.....	.....	.....	171	254	305	381
6–0	.....	.....	.....	157	233	280	350
6–3	.....	.....	.....	.....	214	258	322
6–6	.....	.....	.....	.....	198	238	298
6–9	.....	.....	.....	.....	.....	221	276
7–0	.....	.....	.....	.....	.....	206	257
7–6	.....	.....	.....	.....	.....	178	223
8–0	.....	.....	.....	.....	.....	157	197
8–6	.....	.....	.....	.....	.....	.....	174
9–0	.....	.....	.....	.....	.....	.....	155
9–6	.....	.....	.....	.....	.....	.....	140
10–0	.....	.....	.....	.....	.....	.....	126

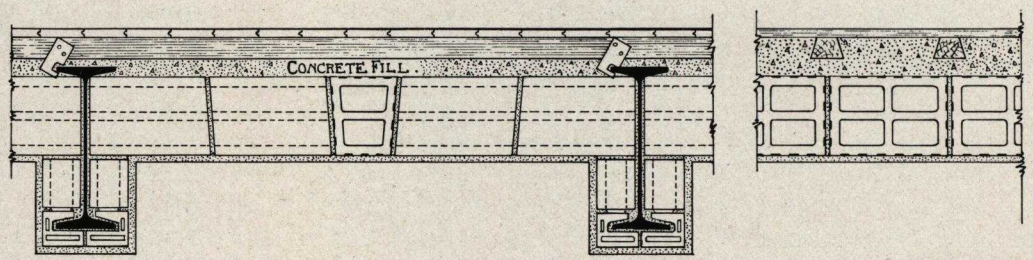
NATCO FLAT ARCH
END CONSTRUCTION



Typical Sections—Standard End Construction



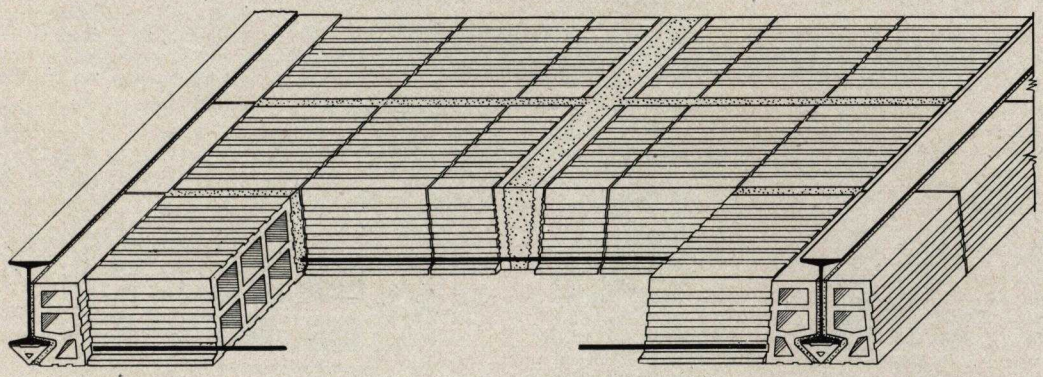
Typical Sections, X-Tile Type—Western Factories Only.



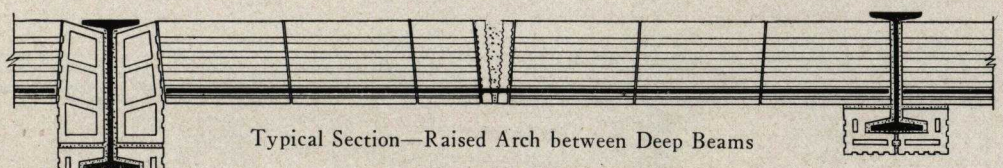
Typical Sections—Raised on Floor Beams
For a paneled ceiling effect

DETAIL FLOOR SECTIONS—TYPICAL SPANS
Showing Cinder Concrete Fill, Wood Flooring, and Plaster in Place

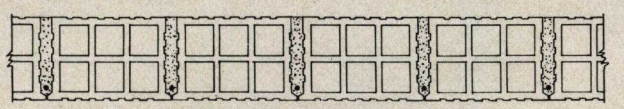
NATCO "NEW YORK" REINFORCED FLAT ARCH



Typical Span, Natco "New York" Arch



Typical Section—Raised Arch between Deep Beams



Cross Section—Typical Arch

THE Natco "New York Arch" was designed for use where a light and cheap, but strong, soundproof, fireproof floor construction with a flat ceiling is required, and is particularly adapted to wide spans in shallow beams. Where light floor construction with deep beams is necessary, it can be secured by setting the tile level with the tops of the beams and using a flat metal lath ceiling, or by omitting the ceiling, a panelled effect is obtained. Where shallow beams are used, the tile are set level on the bottom and 1½ or 2 in. below the bottom of the beams, as may be required by local building codes. Light cinder concrete should be used to level up to the top of the beams.

This arch is formed of self-centering units which are set dry, except the skewbacks, permitting installation by unskilled labor. The "lip" tile Inters when set tight form channels for the mortar ribs 1-in. wide in the direction of the arch, approximately 12-in. on centers, and these Inters are provided in such lengths as to allow for grouting a mortar key at or near the center of the arch. In order to prevent the mortar from flowing into the cells of the end construction Inters, 1-in. tile slabs are used to close the cells. The feature of the mortar key is important in that it eliminates the tile key of rigid dimension, thus avoiding much loss of time in laying out an arch to allow proper space for the final insertion of the key.

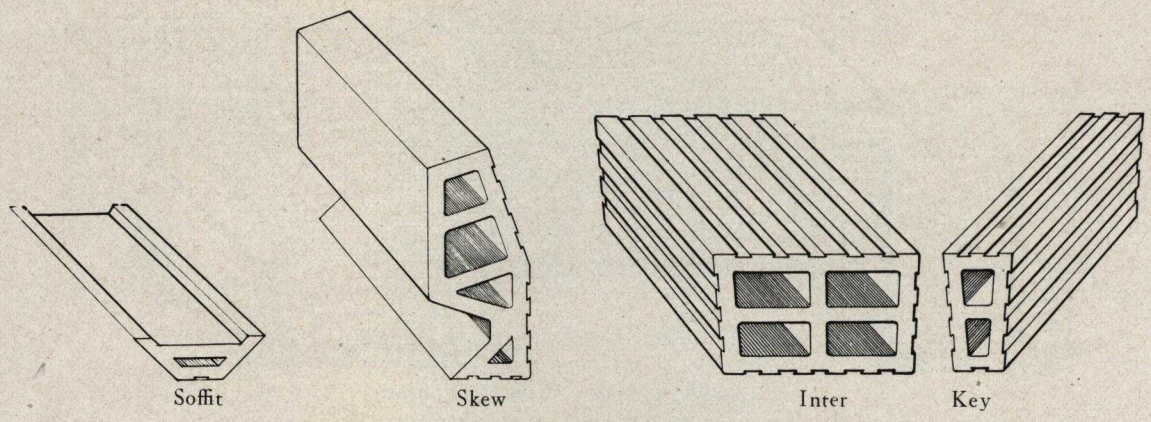
Reinforcement for the arch consists of ¼ or ⅜ inch round rods, placed in the mortar ribs, one rod to each rib, the size of the steel depending upon the span of the arch, and the load to be carried.

Finally, the tile being set, the ribs and keys are grouted with a mortar of one part Portland cement to three parts sand.

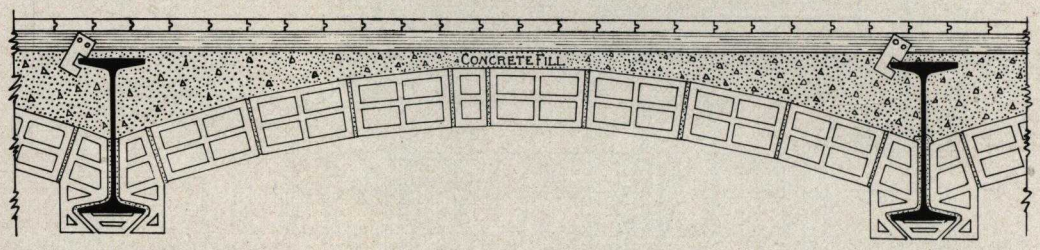
The skewbacks should be carefully bedded against the beams with mortar, and clip tile used with raised arches should also be set with mortar joints.

This arch weighs practically the same as the standard hollow tile arches of equal depth.

NATCO SEGMENTAL ARCH



TYPICAL SHAPES



Typical Section—Standard Segmental Arch. Cinder Concrete Fill and Wood Floor in Place

THIS form of arch is the strongest and cheapest possible. It is particularly adaptable to warehouses, lofts, factories, sidewalks, or wherever great strength is required and a flat ceiling is not necessary.

The 6-in. arch is most commonly used, and is as strong for all ordinary purposes, as the 8-in. of equal rise and thickness of shells and webs.

End construction tile may be used, but they are unsatisfactory unless the arches are of uniform span and rise throughout.

Where a very light, strong arch is required in deep beams, and a flat ceiling is also demanded, this result can be obtained by using a suspended ceiling below the beam.

The most effective location for the tie rods to counteract the thrust is near the bottom of the beams. They may be placed there and painted, or set higher and protected by the arch. If this is done the rods in the end spans should be made forked or double rods set crossing each other. The table on page 11 gives the strength of various thicknesses of arches for different spans and rise.

SAFE LOADS—NATCO SEGMENTAL ARCH

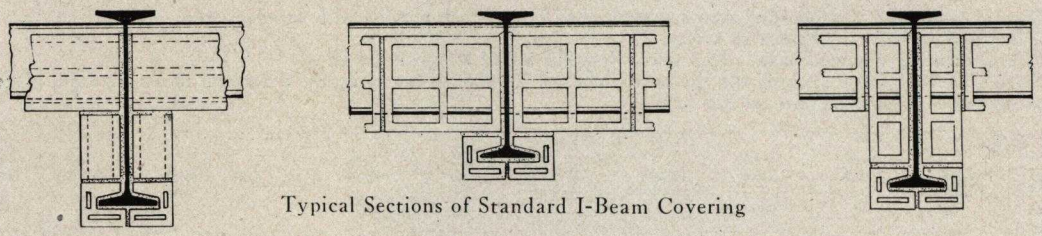
Given for tile with the following sectional areas (per foot of arch parallel with beams): 4-in. arch, 28 sq. in.; 6 in. 36 sq. in.; 8-in. 43 sq. in. Factor of safety, 7.

Rise in inches per foot of span. Example: Rise 1½ for 12 ft. span=18 in.

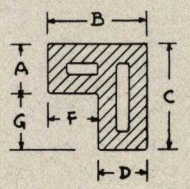
NOTE—The weight of the arch tile has been deducted in table so that only the dead load of concrete fill, plastering, etc., must be deducted to obtain net live load.

Spans ft. and in.	Rise in.	6-in. Arch lb.	8-in. Arch lb.	Spans ft. and in.	Rise in.	6-in. Arch lb.	8-in. Arch lb.	Spans ft. and in.	Rise in.	6-in. Arch lb.	8-in. Arch lb.
	¾	902	1078		¾	411	491		¾	261	312
	1	1184	1414		1	551	658		1	351	419
4	1¼	1485	1774	8–6	1¼	678	810	13	1¼	437	522
	1½	1740	2079		1½	806	963		1½	519	620
	1¾	1986	2373		1¾	926	1106		1¾	596	712
	2	2233	2667		2	1037	1239		2	670	801
	¾	792	946		¾	386	461		¾	240	287
	1	1044	1247		1	518	619		1	326	390
4–6	1¼	1313	1568	9	1¼	645	770	14	1¼	406	485
	1½	1539	1838		1½	758	906		1½	482	575
	1¾	1775	2121		1¾	871	1041		1¾	553	661
	2	1975	2359		2	977	1167		2	619	740
	¾	709	847		¾	364	435		¾	225	268
	1	957	1143		1	489	584		1	302	361
5	1¼	1172	1400	9–6	1¼	608	726	15	1¼	377	450
	1½	1379	1647		1½	721	862		1½	447	534
	1¾	1592	1902		1¾	823	983		1¾	515	616
	2	1773	2118		2	923	1102		2	577	690
	¾	641	766		¾	344	411		¾	209	249
	1	864	1032		1	462	552		1	281	336
5–6	1¼	1062	1269	10	1¼	576	688	16	1¼	353	421
	1½	1266	1512		1½	683	816		1½	419	500
	1¾	1439	1719		1¾	784	937		1¾	481	575
	2	1619	1933		2	879	1050		2	540	645
	¾	585	699		¾	331	396		¾	194	232
	1	788	941		1	438	523		1	265	316
6	1¼	969	1157	10–6	1¼	546	652	17	1¼	330	394
	1½	1154	1379		1½	648	774		1½	392	468
	1¾	1315	1570		1¾	744	889		1¾	452	540
	2	1476	1763		2	832	994		2	506	605
	¾	551	658		¾	315	376		¾	182	218
	1	724	864		1	421	503		1	248	296
6–6	1¼	902	1077	11	1¼	519	621	18	1¼	310	370
	1½	1058	1264		1½	617	737		1½	370	442
	1¾	1218	1455		1¾	709	847		1¾	425	507
	2	1358	1622		2	794	948		2	477	570
	¾	508	606		¾	299	358		¾	173	206
	1	669	799		1	401	480		1	233	279
7	1¼	834	996	11–6	1¼	499	596	19	1¼	293	350
	1½	981	1171		1½	592	707		1½	348	416
	1¾	1127	1346		1¾	680	812		1¾	402	480
	2	1264	1510		2	761	909		2	451	539
	¾	471	563		¾	285	341		¾	163	194
	1	621	741		1	383	458		1	221	265
7–6	1¼	774	925	12	1¼	477	569	20	1¼	277	331
	1½	920	1099		1½	566	676		1½	330	395
	1¾	1049	1253		1¾	649	776		1¾	381	455
	2	1176	1405		2	727	869		2	427	510
	¾	439	525		¾	273	326		¾	153	183
	1	588	703		1	366	437		1	209	250
8	1¼	724	864	12-6	1¼	456	545	21	1¼	263	315
	1½	859	1026		1½	541	646		1½	314	375
	1¾	987	1179		1¾	621	742		1¾	361	432
	2	1099	1312		2	696	832		2	406	485

NATCO GIRDER COVERING



Typical Sections of Standard I-Beam Covering



Die No.	Sq. Ft. Outside Measure	Wt. per Piece	A	B	C	D	E	F	G
G-20	.65	13 lb.	¾″	3⅝″	3¾″	4 ″	2″	2¼″	¾″
G-25	.70	14 lb.	¾″	4 ″	4 ″	4⅜″	2″	2⅝″	13/16″
G-30	.75	15 lb.	⅞″	4¼″	4¼″	4⅝″	2″	3 ″	⅞″
G-35	.80	16 lb.	¾″	4¾″	4¼″	5½″	2″	3½″	1 ″
G-40	.85	17 lb.	¾″	4¾″	4¼″	6 ″	2″	4 ″	1 ″
G-45	.90	18 lb.	¾″	4¾″	4¼″	6½″	2″	4½″	1 ″
G-50	.95	19 lb.	¾″	4¾″	4¼″	7 ″	2″	5 ″	1 ″
G-60	1.05	21 lb.	1 ″	5½″	4½″	8 ″	2″	6 ″	1¼″
L-25	.60	12 lb.	2 ″	4 ″	5 ″	2 ″	.....	2 ″	3 ″
L-26	.90	18 lb.	2 ″	4 ″	8½″	2 ″	.....	2 ″	6½″
L-43	.65	13 lb.	2 ″	6 ″	5 ″	2 ″	.....	4 ″	3 ″
L-46	.95	19 lb.	2 ″	6 ″	8½″	2 ″	.....	4 ″	6½″

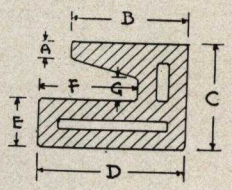
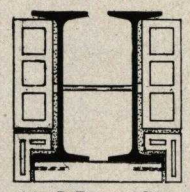
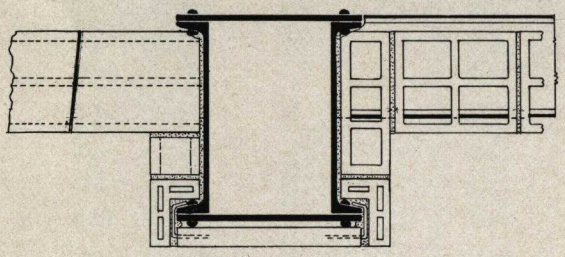


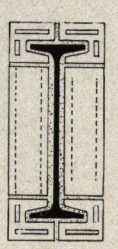
Table of Standard Clip and Angle Tile



Double I-Beam Covering



Typical Box-girder Covering



I-Beam Covering

IT is necessary that girders projecting below the ceiling be protected by 2 in. of hollow tile. Those framed level with the floor beams may be covered by the same amount of hollow tile as used to cover the beams. If heavy plaster cornices are used the girders are protected first by the hollow tile, and the shape required for the plastering is obtained by iron brackets and metal lath, but this latter is not sufficient protection alone.

Experience has proven that well-burned hollow tile has no equal as covering for structural steel or iron, as it is the best non-conductor of heat, and is not destroyed by the action of fire and water. In case of a serious fire the integrity of the whole structure depends upon the thorough protection of the columns and girders, and no reasonable expense should be spared to accomplish this.

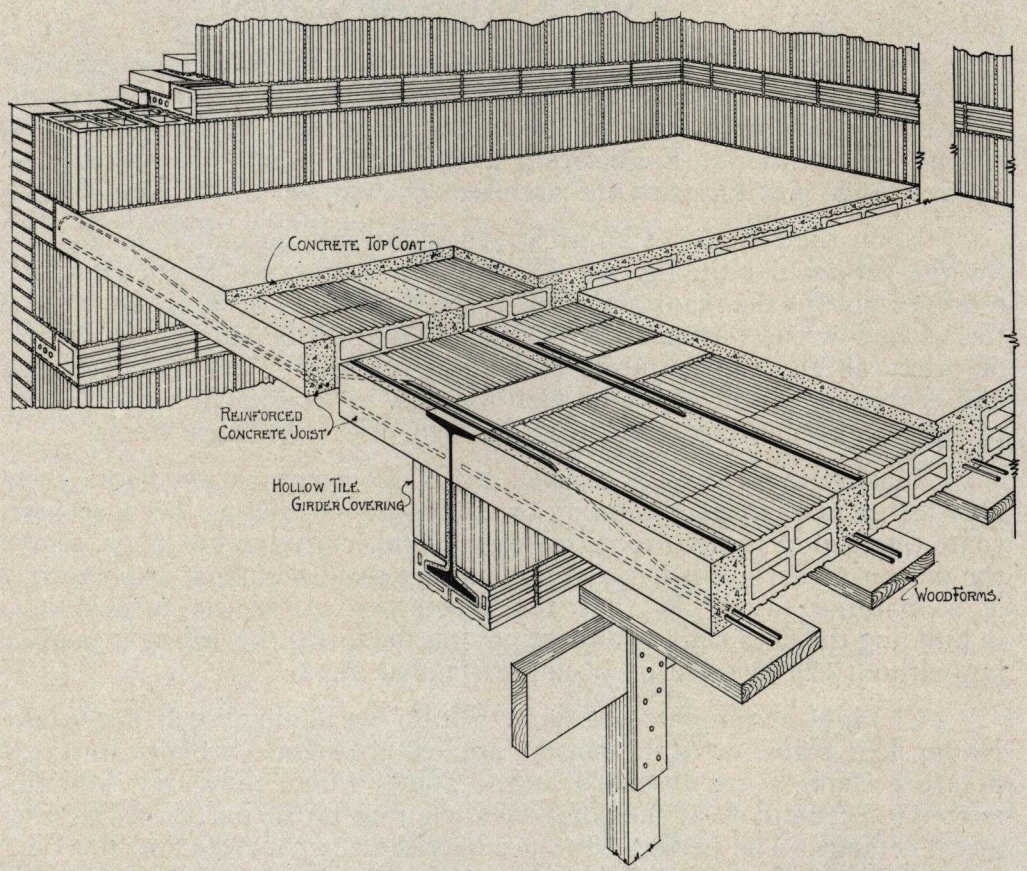
The lower flanges of the beams are usually covered by "clip tile" and the webs by partition tile, as shown. For plate girders and double beams and where the space is wide, the soffit should be hung on metal clips, which are protected, as shown in above details.

The girder covering may be set with the arches or later. If set with the arches, the partition tile which rests upon the clip tile is held in place by the arch. If set later the space between the clip tile and the bottom of the arch is filled by a short tile or brick. The two methods are clearly shown above.

Channel beams should never be used except against brick walls, as it is almost impossible to properly protect them at less expense than cost of I-beams.

NATCO "COMBINATION" LONG-SPAN FLOORS

ONE-WAY SYSTEM



Perspective View—Natco One-Way Combination System—Showing Natco Header Backer Tile in Exterior Walls

NATCO combination floors are particularly adapted to all classes of buildings where long span fireproof floors are required without beams showing in the ceilings. Hollow tile in combination with the load-bearing concrete, reduces the dead load and provides a good plastering surface.

Much in the same way that the modern I-beam was developed from the original rectangular beam by cutting away the inert material on either side until the I shape was developed, so the modern combination long-span hollow tile and concrete floor slab was developed from the original solid slab by cutting away the inert concrete below the neutral axis until a series of connected T-shapes remained. The Natco Hollow Tile make permanent forms in which are cast the series of connected concrete T's as shown on page 15.

It is plain, therefore, that the elimination of inert concrete material and the substitution of hollow tile cuts down the dead weight of the floor construction and is the secret of the economy effected by using a long span combination of Natco Hollow Tile and reinforced concrete.

Our Natco One-Way system, shown above, in which the T-beams run in one direction, eliminates inert concrete more efficiently than any other of the long-span floors on the market that use hollow tile or metal cores, with the exception of the Natcoflor shown on page 24. When constructed of 6-in. tile spaced 4 in. apart and covered with a 2-in. concrete top, this floor has only 44 per cent of its volume in concrete, 56 per cent being hollow tile.

NATCO "COMBINATION" LONG-SPAN FLOORS

APPLICATION OF SYSTEM

DESIGN

On pages 21, 22 and 23 will be found data for designing combination floors, but when the most efficient adaptation of these floors to a particular building requires a detail knowledge of their design and skill in their use, we recommend consultation with our Engineering Department—they will be glad to cooperate in every way possible with the architect or engineer in his floor designs.

APPLICATION

Upon the request of an architect or builder, accompanied by a set of plans for the proposed building, we will apply a system of Natco combination floors most suitable to the plans and furnish a layout of our design. Approximate quantities of hollow tile estimated from this layout will be submitted with a quotation of prices on the tile required, and information on steel reinforcement, concrete and centering will be given in such form as to enable the architect or builder to prepare an estimate of cost from his own prices on those items.

PLASTERING

Plastering on ceilings formed by Natco combination floors costs considerably less per square foot than on expanded metal ceilings, because first, only two coats (instead of three) are necessary; second, considerable labor is saved because the plastering surface is flat and unyielding; third and most important of all, there is a material saving in that the plastering surface is formed automatically in building the floor slab, and on removing the forms the ceiling is ready for plastering without the installation of any expanded metal.

TEMPERATURE STRESSES

Changes in temperature from Winter to Summer will not cause cracks in Natco floor slabs, or in the plaster applied to them. Stresses due to these temperature changes are absorbed at the points where they arise and are not transmitted to accumulate at the points of anchorage at the partitions, as with expanded metal ceilings. The perfect adhesion between the concrete and the tile, bonds the two materials so strongly as to make them act as one material. When metal cores are used in place of tile, the arch formed by two adjacent T-beams has to stand by itself. In the center of this arch, which has a clear span of about 20 inches, there is only the thickness of the slab—usually about 2 or 2½ inches—to take the stresses due to expansion and contraction. It is common practice to specify expansion bars in this slab to take care of these stresses and reinforce the arch at this weak point. On the other hand, the hollow tile in the Natco floors support the arch and take up these stresses. The top of the arch is thicker than with metal cores by the thickness of the shell of the tile. Reinforcement in the concrete top of Natco floors is not necessary.

THEORY

T-shaped joists of reinforced concrete carry the load on the floors. The function of the tile is not only to serve as a permanent form in which the joists are cast, to fireproof the load-carrying concrete in the slab and joists, to stay the stems of the T's, to assist in taking up temperature stresses, and to furnish a good plastering surface, but also to resist with the concrete, compressive and shearing stresses in the floors. All calculations for the concrete joists which carry the load and form the structural part of the floor are based on the universal, accepted engineering practice for T-beam design, and are readily subject to analysis.

The tile in a line of units are all in contact and hold each other securely in the positions indicated on our drawings. They are not displaced by the workmen in pouring the concrete. No re-alignment is necessary. When they are covered

NATCO "COMBINATION" LONG-SPAN FLOORS

with concrete the architect knows that they are in the positions in which he inspected them before concreting.

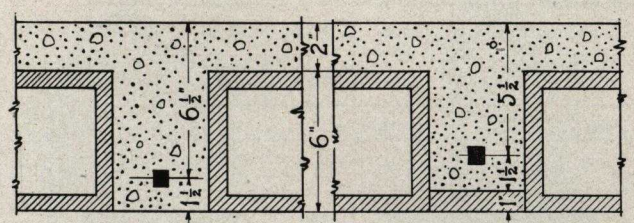
The naturally strong adhesive bond between tile and concrete, aided by the mechanical bond of the scoring on all Natco tile, cause the two materials to act as if they were monolithic. All concrete for floor construction should be mixed to a "quaking" consistency and the tile and concrete are so firmly united that a chisel and sledge-hammer would have to be used to separate them.

FIRE-PROOF-NESS

In these floors, NATCO HOLLOW TILE around which the concrete T-beams are cast, fireproofs the load-carrying concrete of the beams, (above the neutral axis and therefore in compression), against the flames of a fire below. In systems where metal cores are used as permanent forms around which the concrete T-beams are poured, this critical concrete in the slab has no protection from the flames. The expanded metal ceiling is all that stands between the hot flames and the critical slab-concrete; it would soon come down in a hot fire, and the heat would cause the concrete in compression to spall off the under side of the slab. As the full thickness of this slab is absolutely necessary for the strength of the floor, reduction by spalling on the under side would weaken the floor and make it imperative that it be removed and a new slab constructed. In the Natco floors the only concrete exposed to the flames is the bottom of the stems of the T-beams, which is designed only as fireproofing for the reinforcing bars. Experience with fires shows that some of this concrete spalls off where the heat is intense, but cement mortar can be plastered over these places furnishing new fireproofing for the steel. This is a simple process, but the plastering of new cement mortar on old concrete subject to compression in the slab and cast on metal cores, cannot be done, because concrete under stress must be monolithic, and new mortar cannot be made monolithic with old concrete. With Natco floors the plastering surface remains practically undamaged after a fire, and can be re-plastered readily at comparatively slight expense.

ALL-TILE CEILING

Some architects favor a ceiling with a tile surface over the entire area, for which purpose we furnish a tile slab to be laid between the hollow tile. This is scored on both sides so as to furnish a secure bond with the concrete joist and the plaster. When the all tile ceiling is employed, the effective depth of the floor is decreased by the thickness of the tile slab in the joist, as illustrated in the accompanying sketch, and to provide a necessary strength, the floor thickness must be increased. It has been found that the all tile ceiling is not essential where good construction is obtained in installing the floors.



Effective Depth 6½" COMBINATION CEILING

Effective Depth 5½" ALL-TILE CEILING

PERMANENCY

Combination floors of tile and concrete are a permanent construction and, for all practical calculation, can be said to have no depreciation. There is no reason why a modern fireproof, sanitary schoolhouse, hospital or residence with floors constructed of concrete and our tile should not last and give service for hundreds of years. A home or an institutional building should be a permanent structure, built for the use of many generations, and viewed with this perspective, floors requiring expanded metal ceilings are a temporary construction.

NATCO "COMBINATION" LONG SPAN FLOORS
SPECIFICATIONS

GENERAL—The floor construction is to be of the type known as the Natco Long-Span Floor System, as indicated for the several bays on the drawings. In general this system consists of 4-in. reinforced concrete joists running in one direction and spaced 16 in. on centers with Hollow Tile between them. All tile are to be covered with a 2 or 2½-in. concrete top as required, cast monolithic with the concrete joists. All floor slabs are to have 4-in. bearing on the walls.

CONCRETE—All concrete used in the floor construction shall consist of 1 part portland cement, 2 parts clean sharp sand, and 4 parts broken stone or gravel of such size as will pass through a ¾-in. ring. It shall be of wet mixture and must be well tamped and worked around the reinforcing steel after pouring. The placing of concrete must be a continuous operation, and the full depth of floor must be poured at one time.

REINFORCING STEEL—Rolled deformed, or twisted bars offering a mechanical bond with the concrete satisfactory to the architect are to be used as reinforcement for the floor construction. They are to be free from mill and rust scales. No bars pitted by rust are to be used. Reinforcement is to be so placed as to allow of ¾-in. of concrete between the steel and the forms.

TILE—The depth of hollow tile fillers and the size of steel reinforcing rods are determined by the span and load to be carried and are to be of the size indicated on detail structural drawings to be prepared by the tile manufacturers under the supervision of the Architect. All tile must be wet before concrete is placed, so as to insure a good bond with the concrete. Tile shall be manufactured by National Fire Proofing Company, of hard burned fire clay, free from damaging impurities, and properly scored on all exterior surfaces.

FORMS—Forms must be of such size as to prevent deflection under the weight of the wet concrete, and must be provided in such quantity as to permit of speedy work. Care must be taken not to remove the forms before the concrete is set. Under long spans a center line of supports must be maintained for at least three weeks after the concrete has been poured. In cold weather the contractor must leave the forms in place until directed by the architect to remove them.

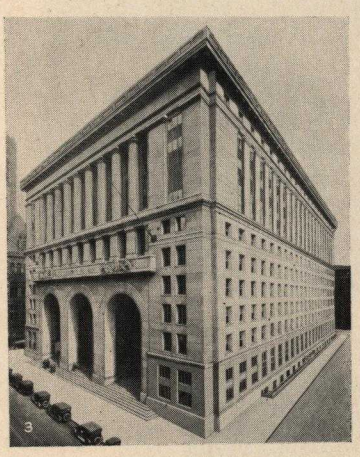
Weights of Natco Combination Floors and Concrete Required

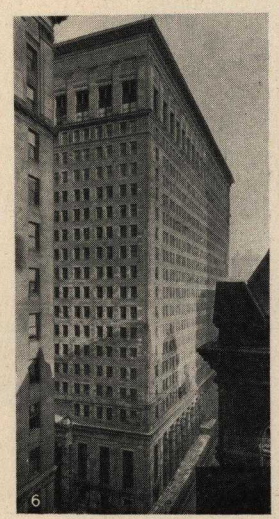
Thickness of Tile	3 in.	4 in.	5 in.	6 in.	7 in.	8 in.	9 in.	10 in.	12 in.	15 in.
2-in. Concrete Top—4-in. Joists, 16-in. on centers										
Weight per sq. ft. of floor area	45 lb.	50 lb.	55 lb.	60 lb.	65 lb.	70 lb.	75 lb.	80 lb.	90 lb.	105 lb.
Cu. ft. concrete per sq. ft. floor	0.229	0.250	0.271	0.292	0.313	0.333	0.354	0.375	0.417	0.479
2½-in. Concrete Top—4-in. Joists, 16-in. on centers										
Weight per sq. ft. of floor area	51 lb.	56 lb.	61 lb.	66 lb.	71 lb.	76 lb.	81 lb.	86 lb.	96 lb.	111 lb.
Cu. ft. concrete per sq. ft. floor	0.271	0.292	0.313	0.333	0.354	0.375	0.396	0.417	0.458	0.521

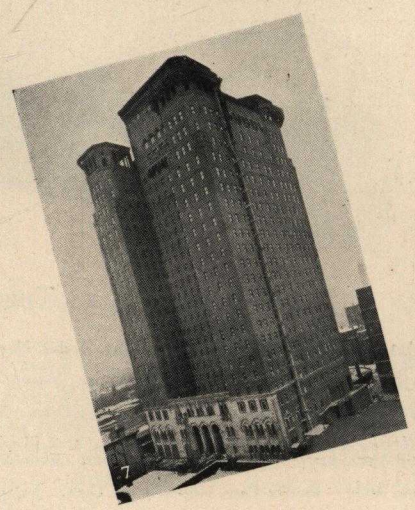
Weight and Areas of Reinforcing Bars

Size in in.	¼	⅜	½	⅝	¾	⅞	1	1⅛	1¼
Square Bars									
Area in sq. in.	.063	.141	.250	.391	.563	.766	1.000	1.266	1.563
Weight per ft. in lb.	.21	.48	.85	1.33	1.91	2.60	3.40	4.30	5.31
Round Rods									
Area in sq. in.	.049	.110	.196	.307	.442	.601	.785	.994	1.227
Weight per ft. in lb.	.17	.38	.67	1.04	1.50	2.04	2.67	3.38	4.17

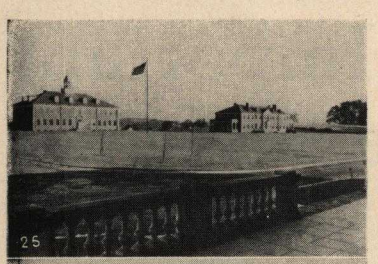
Natco Hollow Tile Played an Important Part in the Construction of these Buildings

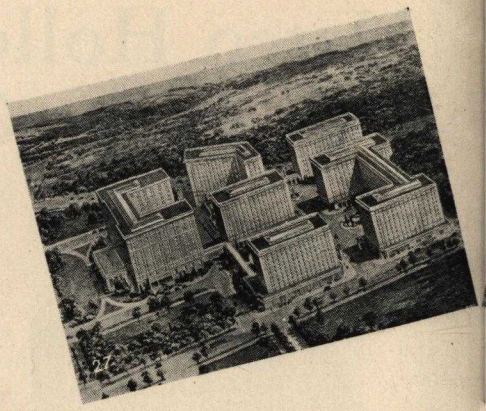


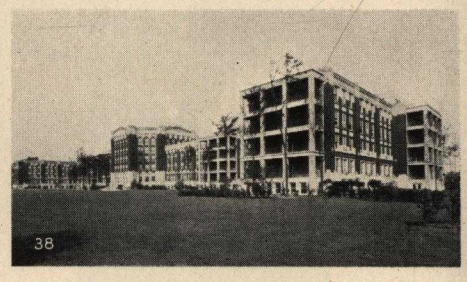


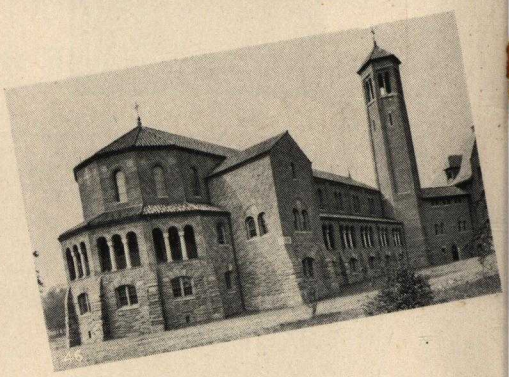


1. Federal Reserve Bank Chicago. Graham, Anderson, Probst & White, Archts. John Griffiths & Sons, Cont. *Natco Flat Arch Floors*
2. U. S. Custom House, New York. Cass Gilbert, Archt. John Peirce Co., Cont. *Natco Flat Arch Floors, Part. and Furring*
3. City-County Bldg., Pittsburgh. E. B. Lee, Archt. Henry Hornbostel, Assoc. Archt. Jas. L. Stuart Co., Cont. *Natco Partitions and Flat Arch Floors*
4. Woolworth Bldg., New York. Cass Gilbert, Archt. Thompson-Starrett Co., Cont. *Natco Flat Arch Floors, Part. and Furring.*
5. Union Trust Bldg., Pittsburgh. F. J. Osterling, Archt. Geo. A. Fuller Co., Cont. *Natco Part. and Flat Arch Floors*
6. Ill. Merchants Bank Bldg., Chicago. Graham, Anderson, Probst & White, Archts. Henry Ericsson Co., Cont. *Natco Flat Arch Floors*
7. Chicago Allerton Club, Chicago. Murgatroyd & Ogden, New York, Archts. McLennan Const. Co., Cont. *Natco Flat Arch Floors*
8. Hotel Shelton, New York. Arthur L. Harmon, Archt. Shelton Holding Co., Cont. *Natco Header Backer Walls*
9. Dime Bank Bldg., Detroit. D. H. Burnham & Co., Chicago, Archts. Lanquist & Illsley Co., Cont. *Natco Flat Arch Floors and Natco Part*
10. London Guarantee & Accident Bldg., Chicago. Alfred S. Alschuler, Archt. Dwight P. Robinson Co., Cont. *Natco Flat Arch Floors*



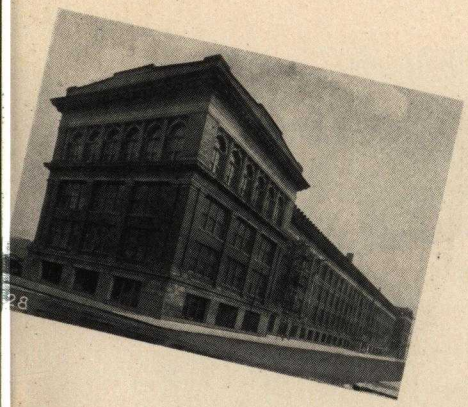


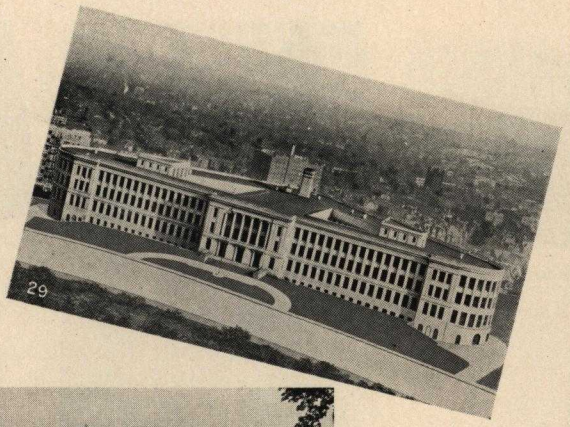


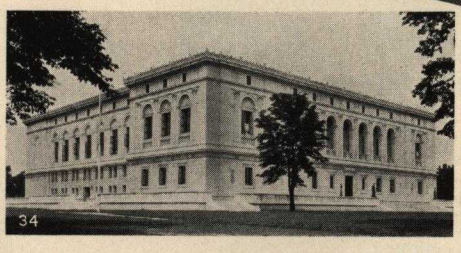


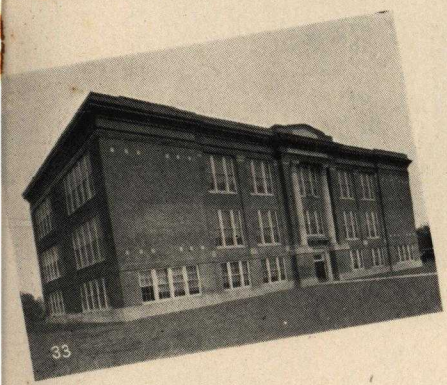
NATCO HOLLOW TILE—THE CHOIC

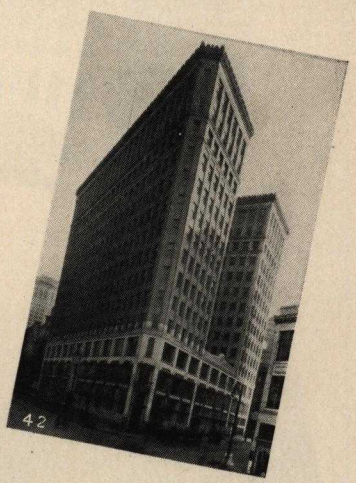
25. Part of group of buildings of Shadyside Academy, Aspinwall, Pa. E. P. Mellon, Archt., New York. Mellon-Stuart Co., Cont. *Natcoflor Tile Floors*
26. University Club, Pittsburgh. Henry Hornbostel, Archt. W. T. Grange Co., Cont. *Natco Part. and Flat Arch Floors*
27. Schenley Apts., Pittsburgh. Rutan, Russell & Wood, Archts. Mellon-Stuart Co., Cont. *Natcoflor Tile Floors*
28. Tilden High School, Chicago John C. Christensen, Archt. *Natco Part. and Flat Arch Floors*
29. Schenley High School, Pittsburgh. Edward Stotz, Archt. Jas. L. Stuart Co., Cont. *Natco Combination Floors*
30. Empire Hotel, New York. Fred I. Merrick, Archt. Empire Cont. Organization, Cont. *Natco Header Backer Walls and Part*
31. Crane High School, Chicago. John C. Christensen, Archt. A. & E. Anderson Co., Cont. *Natco Part. and Flat Arch Floors*
32. Concourse Plaza Hotel, New York. Maynicke & Franke, Archts. Niewenhous Co., Inc. Cont. *Natco Header Backer Walls and Part.*
33. Hampton High School, Hampton, Va. Chas. M. Robinson, Richmond, Va., Archt. J. W. Davis, Newport News, Va., Cont. *Natco Header Backer Walls*
34. Detroit Public Library, Detroit. Cass Gilbert, Archt. Geo. A. Fuller Co., Cont. *Natco Part. and Flat Arch Floors*
35. Loft Bldg., New York. Geo. & Edw. Blum, Archts. Haascourt Realty Co., Cont. *Natco Header Backer Walls*
36. Chamber of Commerce Bldg., Pittsburgh. E. B. Lee & J. P. Piper, Archts. Thompson-Starrett Co., Cont. *Natco Part. and Flat Arch Floors*
37. Municipal Bldg., New York. McKim, Mead & White, Archts. Thompson-Starrett Co., Cont. *Natco Flat Arch Floors, Part. and Furring*
38. Henry Ford Hospital, Detroit. Albert Wood, Archt. Albert A. Albrecht, Cont. *Natco Part. and Natco Bakup Walls*

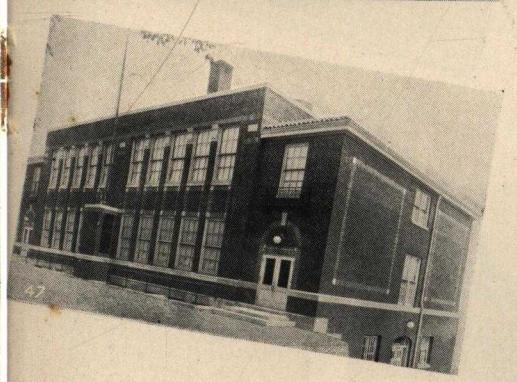






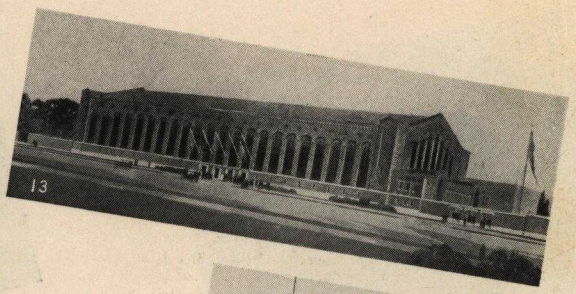


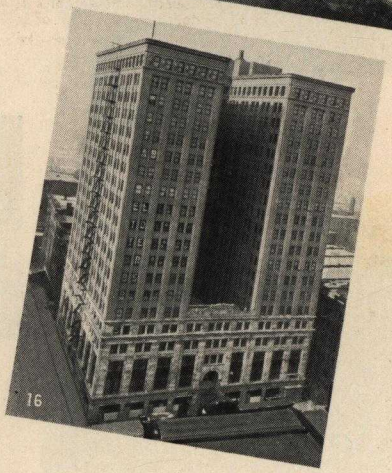


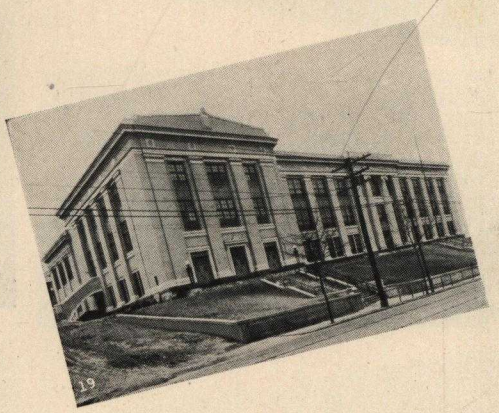


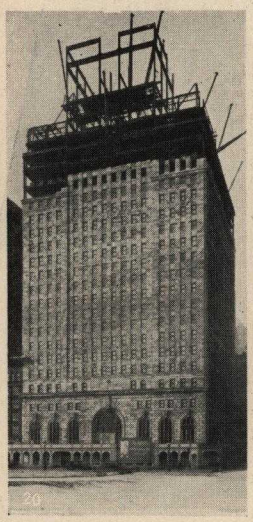
OF AMERICA'S LEADING ARCHITECTS

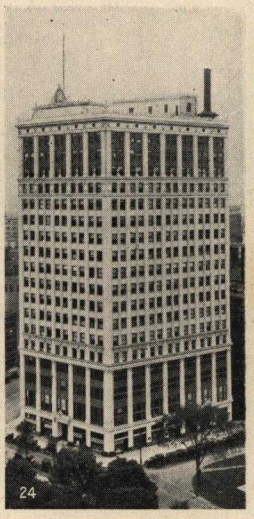
39. Herzl Grammar School, Chicago. John C. Christensen, Archt. *Natco Flat Arch Floors*
40. Kaufman & Baer Dept. Store, Pittsburgh. G. Starrett & Van Vleck, Archts. *Natco Part. and Flat Arch Floors*
41. Blumstein Dept. Store, New York. Robert D. Kohn, Archt. C. A. Cowen & Co., Cont. *Natco Header Backer Walls and Part*
42. Lafayette Bldg., Detroit. C. Howard Crane, Archt. Otto Misch Co., Cont. *Natco Part., Bakup Walls, and Combination Floors*
43. Whitehall Bldg., New York. H. J. Hardenbergh, Archt. of old building. Clinton & Russell, Archts. for addition. Geo. A. Fuller Co., Cont. *Natco Flat Arch Floors, Part. and Furring*
44. Mail Service Bldg., New York Warren & Wetmore, Archts. Jas. Stewart & Co., Cont. *Natco Header Backer Walls*
45. Town Hall, W. 43d St., New York. McKim, Mead & White, Archts. *Natco Header Backer Walls*
46. Mt. Aloysius Academy, Cresson, Pa. Comes, Perry & McMullen, Archts. *Natco Header Backer Walls*
47. Ross Township School, Allegheny Co., Pa. Press C. Dowler, Archt. Williams & Haas, Cont. *Natco Header Backer Walls*
48. Hotel Statler, Detroit. Geo. B. Post, Archt. Geo. A. Fuller Co., Cont. *Natco Part., Bakup Walls and Flat Arch Floors*
49. First Nat. Bank Bldg., Detroit. Albert Kahn, Archt. Foundation Co., Cont. *Natco Bakups and Col. Covering*
50. Rosenbaum Co. Dept. Store, Pittsburgh. Jarvis Hunt, Archt. Jas. L. Stuart Co., Cont. *Natco Part. and Flat Arch Floors*
51. Apt. Bldg., 104th & Broadway, New York. Carrere & Hastings, Shreve, Lamb & Blake, Archts. Longacre Engr. & Cont. Co., Cont. *Natco Header Backer Walls, Part. and Furring*
52. Belden Hotel, Chicago. Fridstein & Co., Chicago, Engrs. & Archts. *Natco Flat Arch Floors*
53. National Biscuit Co., Detroit. A. G. Zimmerman, Archt. Geo. A. Fuller Co., Cont. *Natco Part. and Segmental Arch Floors*
54. Chicago Methodist Temple Bldg., Chicago. Holabird & Roche, Archts. John Griffiths & Sons, Cont. *Natco Flat Arch Floors*











11. Greenfield Public School, Pittsburgh. Kiehnel & Elliott, Archts. A. & S. Wilson Co., Cont. *Natcofior Tile Floors*
12. Wrigley Bldg., Chicago. Graham, Anderson, Probst & White, Archts. Lanquist & Illsley Co., Cont. *Natco Part. and Flat Arch Floors*
13. University of Michigan Field House. Smith, Hinchman & Grylls, Archts. H. G. Christman Co., Cont. *Natco Part. and Bakup Walls*
14. Detroit Police Station. Albert Kahn, Archt. Otto Misch Co., Cont. *Natco Part. and Bakup Walls*
15. Apthorp Apt., New York. Clinton & Russell, Archts. John I. Downey, Inc., Cont. *Natco Flat Arch Floors, Part. and Furring*
16. Burnham Bldg., Chicago. D. H. Burnham & Co., Archts. Starrett Bros. Co., Cont. *Natco Flat Arch Floors*
17. Cumberland St. Hospital, Brooklyn. Ludlow & Peabody, Archts. Albert Winternitz, Cont. *Natco Header Backer Walls and Part.*
18. Hotel Manchester, Middletown, Ohio. Frank L. Packard, Columbus, Archt. *Natco Header Backer Walls.*
19. Perry High School, Pittsburgh. R. Maurice Trimble, Archt. Williams and Hass, Cont. *Natco Part., Walls and Combination Floors*
20. Straus Bldg., Chicago. Graham, Anderson, Probst & White, Archts. Thompson-Starrett Co., Cont. *Natco Flat Arch Floors*
21. Office Bldg., 1200 Washington Blvd., Detroit. Louis Kamper, Archt. Otto Misch Co., Cont. *Natco Part., Bakup Walls and Combination Floors*
22. Masonic Temple, Detroit. Geo. D. Mason & Co., Archts. H. G. Christman Co., Cont. *Natco Part. and Bakup Walls*
23. Park Lexington Bldg., New York. Warren & Wetmore, Archts. T. C. Desmond Co., Cont. *Natco Header Backer Walls*
24. David Whitney Bldg., Detroit. Graham, Anderson, Probst & White, Archts. Lanquist & Illsley Co., Cont. *Natco Part. and Flat Arch Floors*

NATCO "COMBINATION" LONG-SPAN FLOORS

DATA FOR DESIGNING PURPOSES

The upper figures in tables denote the depth of tile; the lower figures indicate the area of reinforcing steel required in each concrete joist. Thickness of floor=depth of tile+2 in. of concrete top.

The tables below and on the following page are so arranged that they can be used for floor slabs freely supported at both ends, semi-continuous, or continuous.

For slabs freely supported at both ends (simple span) use loads given opposite $\frac{WL}{8}$

For slabs freely supported at one end and continuous over other support use loads given opposite $\frac{WL}{10}$

For slabs continuous over both supports use loads given opposite $\frac{WL}{12}$

For semi-continuous and continuous spans proper reinforcement must be provided in top of slab over support to take care of negative bending moment. Where loads for moment $\frac{WL}{12}$ are used, shear must be investigated.

2 IN. CONCRETE TOP

fc. 650 lb. per sq. in.
fs. 16000 lb. per sq. in.
Shear 60 lb. per sq. in.

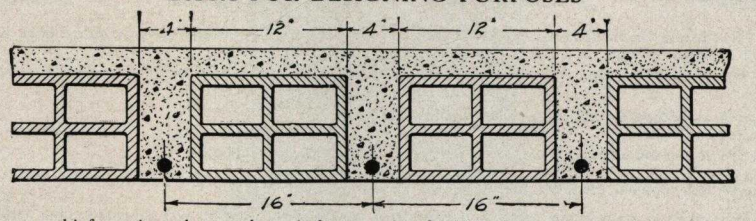
$\frac{Ec}{Es}=\frac{1}{15}$

¾ in. of concrete below reinforcement
4 in. concrete joists 16 in. on centers.

Bending Moment	TOTAL SAFE LOADS (Dead & Live)											
$\frac{W\ L}{12}$	150	165	180	195	210	225	240	260	300	335	375	450
$\frac{W\ L}{10}$	125	135	150	160	175	185	200	220	250	280	310	375
$\frac{W\ L}{8}$	100	110	120	130	140	150	160	175	200	225	250	300
Span 6′-0″						3/.20	3/.22	3/.24	3/.28	4/.24	4/.27	5/.27
" 7′-0″	3/.19	3/.20	3/.22	3/.24	3/.26	3/.28	3/.30	4/.26	4/.30	5/.27	5/.30	6/.31
" 8′-0″	3/.24	3/.26	3/.29	3/.31	3/.34	3/.36	4/.31	4/.34	5/.32	5/.36	6/.34	7/.35
" 9′-0″	3/.31	3/.33	3/.37	3/.40	4/.34	4/.36	4/.39	5/.35	5/.40	6/.38	7/.37	8/.40
" 10′-0″	3/.38	3/.41	3/.46	4/.39	4/.42	4/.45	5/.40	5/.44	6/.42	7/.41	8/.41	9/.44
" 11′-0″	3/.46	4/.39	4/.44	4/.47	5/.42	5/.45	5/.48	6/.45	7/.45	7/.50	8/.49	10/.48
" 12′-0″	4/.43	4/.47	4/.52	5/.46	5/.50	5/.53	6/.49	6/.54	7/.53	8/.53	10/.47	12/.48
" 13′-0″	4/.51	4/.55	5/.50	5/.54	5/.59	6/.53	6/.57	7/.55	8/.55	9/.55	10/.56	12/.57
" 14′-0″	4/.59	5/.53	5/.58	5/.63	6/.58	6/.61	7/.58	7/.64	8/.64	10/.58	12/.54	15/.53
" 15′-0″	5/.56	5/.61	5/.67	6/.61	6/.67	7/.61	7/.66	8/.65	9/.66	10/.67	12/.63	15/.61
" 16′-0″	5/.64	5/.69	6/.65	6/.70	7/.66	7/.70	8/.67	9/.66	10/.68	12/.64	12/.71	15/.70
" 17′-0″	6/.61	6/.67	6/.74	7/.68	7/.75	8/.70	8/.76	9/.75	10/.77	12/.73	15/.65	
" 18′-0″	6/.69	6/.75	6/.82	7/.77	8/.74	8/.78	9/.76	10/.76	12/.73	12/.81	15/.73	
" 19′-0″	6/.76	6/.83	7/.80	7/.86	8/.83	9/.78	9/.85	10/.85	12/.81	15/.73	15/.81	
" 20′-0″	7/.74	7/.80	7/.89	8/.84	8/.91	9/.87	10/.85	12/.79	12/.90	15/.81	15/.90	
" 21′-0″	7/.81	7/.89	8/.87	8/.93	9/.91	9/.96	10/.94	12/.87	15/.80	15/.90		
" 22′-0″	7/.89	8/.86	8/.95	9/.91	9/.99	10/.95	12/.87	12/.95	15/.88	15/.98		
" 23′-0″	8/.86	8/.93	8/1.03	9/.98	10/.98	10/1.03	12/.94	12/1.03	15/.95			
" 24′-0″	8/.94	8/1.02	9/1.01	9/1.08	10/1.07	12/.96	12/1.03	15/.92	15/1.05			
" 25′-0″	8/1.02	9/1.00	9/1.10	10/1.07	12/.98	12/1.03	12/1.12	15/1.00	15/1.13			

NATCO "COMBINATION" LONG-SPAN FLOORS

DATA FOR DESIGNING PURPOSES



The load tables are for general information only as each particular operation should be designed in accordance with actual conditions.
We recommend that the architect call on our Engineering Department for the service which their expert knowledge enables them to render, as described on page 12, under the headings of "Application of Systems" and "Detail Drawings."

Where loads for moment $\frac{WL}{12}$ or $\frac{WL}{10}$ are used, shear must be investigated.

2 IN. CONCRETE TOP

fc. 700 lb. per sq. in.
fs. 18000 lb. per sq. in.
Shear 60 lb. per sq. in.

$\frac{Ec}{Es} = \frac{1}{15}$

¾ in. of concrete below reinforcement
4 in. concrete joists 16 in. on centers.

Bending Moment	TOTAL SAFE LOADS (Dead & Live)											
$\frac{WL}{12}$	150	165	180	195	210	225	240	260	300	335	375	450
$\frac{WL}{10}$	125	135	150	160	175	185	200	220	250	280	310	375
$\frac{WL}{8}$	100	110	120	130	140	150	160	175	200	225	250	300
Span 6'-0"						3/.18	3/.20	3/.21	3/.25	3/.28	4/.24	4/.29
" 7'-0"	3/.17	3/.18	3/.20	3/.22	3/.23	3/.25	3/.27	3/.29	3/.33	4/.30	4/.33	5/.33
" 8'-0"	3/.22	3/.24	3/.26	3/.28	3/.30	3/.33	3/.35	3/.38	4/.34	4/.39	5/.35	6/.36
" 9'-0"	3/.28	3/.30	3/.33	3/.36	3/.39	3/.41	3/.44	4/.38	4/.43	5/.40	5/.45	6/.46
" 10'-0"	3/./34	3/.37	3/.41	3/.44	4/.38	4/.40	4/.43	4/.47	5/.44	5/.50	6/.47	7/.49
" 11'-0"	3/.41	4/.36	4/.39	4/.42	4/.45	4/.49	4/.52	5/.47	5/.54	6/.51	7/.50	8/.53
" 12'-0"	4/.39	4/.43	4/.46	4/.50	4/.54	5/.48	5/.51	5/.56	6/.54	7/.53	8/.52	9/.56
" 13'-0"	4/.45	4/.50	4/.54	5/.49	5/.52	5/.56	5/.60	5/.66	6/.64	7/.62	8/.62	9/.66
" 14'-0"	4/.53	5/.48	5/.52	5/.56	5/.61	5/.65	6/.59	6/.65	7/.64	8/.64	9/.64	10/.70
" 15'-0"	5/.50	5/.55	5/.60	5/.65	6/.60	6/.64	6/.68	6/.74	7/.74	8/.74	10/.67	12/.67
" 16'-0"	5/.57	5/.62	5/.68	6/.63	6/.68	6/.72	6/.77	7/.73	8/.74	9/.75	10/.76	12/.77
" 17'-0"	5/.64	6/.60	6/.65	6/.71	6/.76	7/.71	7/.76	7/.83	8/.84	9/.85	10/.85	12/.86
" 18'-0"	6/.61	6/.67	6/.73	6/.79	7/.74	7/.80	7/.85	8/.82	9/.84	10/.86	12/.81	15/.78
" 19'-0"	6/.68	6/.75	7/.71	7/.77	7/.83	7/.89	8/.84	8/.92	9/.94	10/.96	12/.90	15/.88
" 20'-0"	6/.75	7/.72	7/.79	7/.85	7/.92	8/.87	8/.93	9/.91	10/.95	12/.90	12/1.00	15/.97
" 21'-0"	7/.72	7/.80	7/.87	8/.83	8/.90	8/.96	9/.92	9/1.00	10/1.04	12/.99	15/.89	15/1.06
" 22'-0"	7/.79	7/.87	8/.84	8/.91	8/.98	9/.95	10/.92	10/1.00	12/.97	12/1.09	15/.98	
" 23'-0"	7/.87	8/.85	8/.92	8/1.00	9/.97	10/.94	10/1.00	10/1.09	12/1.05	15/.96	15/1.06	
" 24'-0"	8/.84	8/.92	8/1.00	9/.98	10/.95	10/1.02	10/1.09	12/1.00	12/1.15	15/1.04	15/1.16	
" 25'-0"	8/.91	8/1.00	9/.98	10/.96	10/1.03	10/1.11	12/1.00	12/1.09	15/1.01	15/1.13		

NATCO "COMBINATION" LONG-SPAN FLOORS

DATA FOR DESIGNING PURPOSES

The load tables are for general information only as each particular operation should be designed in accordance with actual conditions. Where loads for moment $\frac{WL}{12}$ are used, shear must be investigated.

2½-IN. CONCRETE TOP

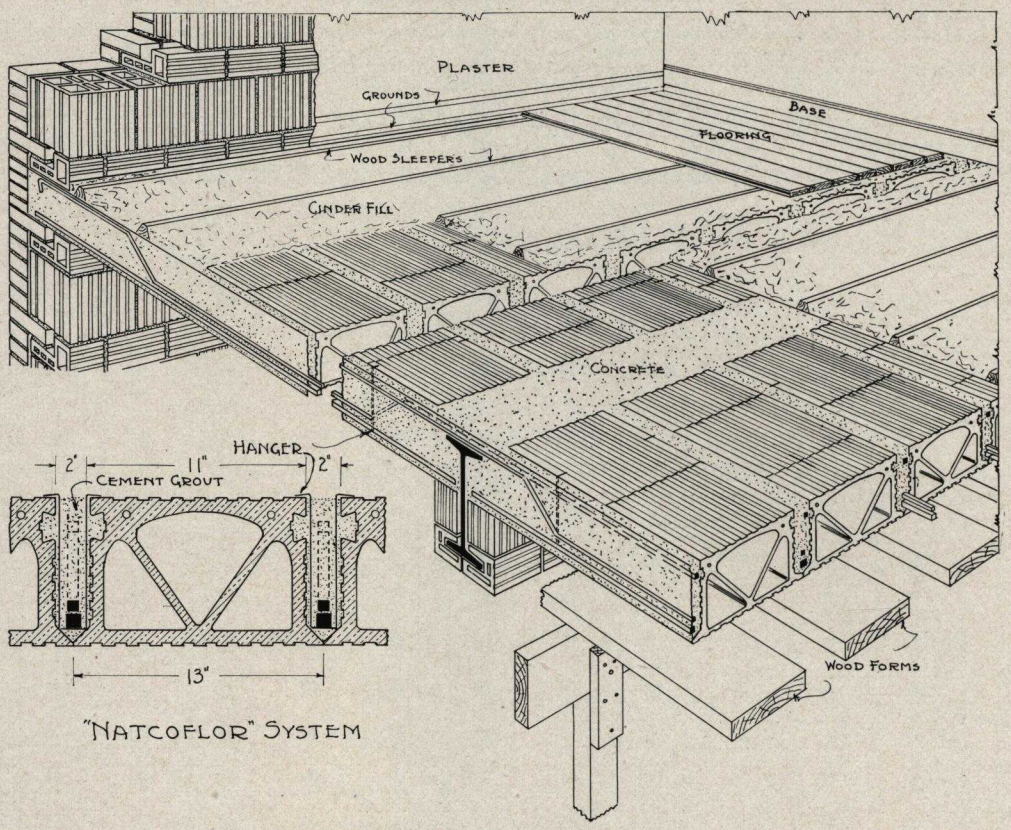
fc. 650 lb. per sq. in.
fs. 16000 lb. per sq. in.
Shear 60 lb. per sq. in.

$\frac{Ec}{Es} = \frac{1}{15}$

¾-in. of concrete below reinforcement
4-in. concrete joists 16-in. on centers.

Bending Moment	TOTAL SAFE LOADS (Dead & Live)											
$\frac{W\ L}{12}$	150	165	180	195	210	225	240	260	300	335	375	450
$\frac{W\ L}{10}$	125	135	150	160	175	185	200	220	250	280	310	375
$\frac{W\ L}{8}$	100	110	120	130	140	150	160	175	200	225	250	300
Span 7′-0″	3/.17	3/.18	3/.20	3/.21	3/.23	3/.24	3/.26	3/.29	4/.27	4/.30	5/.28	6/.29
" 8′-0″	3/.22	3/.23	3/.26	3/.28	3/.30	3/.32	3/.34	4/.31	4/.35	5/.33	5/.36	7/.33
" 9′-0″	3/.27	3/.29	3/.33	3/.35	3/.38	4/.33	4/.35	4/.39	5/.37	6/.36	6/.40	8/.38
" 10′-0″	3/.34	3/.36	3/.40	3/.43	4/.38	4/.40	4/.44	5/.40	5/.46	6/.44	7/.43	9/.42
" 11′-0″	3/.41	3/.44	3/.49	4/.42	4/.46	4/.49	5/.44	5/.49	6/.48	7/.47	8/.46	9/.51
" 12′-0″	3/.48	4/.43	4/.47	4/.51	4/.55	5/.49	5/.53	6/.50	7/.50	8/.50	9/.50	10/.55
" 13′-0″	4/.46	4/.50	4/.55	4/.59	5/.54	5/.57	6/.53	6/.59	7/.59	8/.59	9/.58	12/.55
" 14′-0″	4/.53	4/.58	4/.64	5/.57	5/.63	6/.57	6/.62	7/.60	8/.61	9/.61	10/.62	12/.63
" 15′-0″	4/.61	5/.56	5/.62	5/.66	6/.62	6/.66	7/.62	7/.69	9/.63	10/.64	12/.60	15/.59
" 16′-0″	5/.59	5/.64	5/.70	6/.65	6/.71	7/.66	7/.71	8/.70	9/.72	10/.73	12/.69	15/.68
" 17′-0″	5/.66	5/.72	6/.68	6/.73	7/.70	7/.74	8/.71	9/.71	10/.73	12/.70	12/.77	15/.76
" 18′-0″	5/.74	6/.69	6/.77	6/.82	7/.79	8/.74	8/.80	9/.80	10/.82	12/.78	15/.71	
" 19′-0″	6/.71	6/.77	6/.85	7/.80	8/.78	8/.83	9/.81	10/.81	12/.78	12/.87	15/.79	
" 20′-0″	6/.79	6/.86	7/.83	7/.89	8/.87	8/.92	9/.89	10/.90	12/.86	15/.79	15/.87	
" 21′-0″	6/.87	7/.83	7/.92	8/.87	8/.96	9/.91	10/.90	12/.84	12/.95	15/.87	15/.96	
" 22′-0″	7/.84	7/.91	7/1.00	8/.96	9/.95	9/.100	10/.98	12/.92	15/.85	15/.95		
" 23′-0″	7/.91	7/.98	8/.97	8/1.04	9/1.02	10/1.00	12/.91	12/1.00	15/.92	15/1.03		
" 24′-0″	7/1.00	8/.97	8/1.07	9/1.04	10/1.02	10/1.09	12/1.00	12/1.09	15/1.01			
" 25′-0″	8/.97	8/1.05	9/1.04	9/1.11	10/1.11	12/1.00	12/1.08	15/.97	15/1.10			
" 26′-0″	8/1.04	8/1.12	9/1.13	10/1.11	12/1.02	12/1.08	12/1.17	15/1.04	15/1.19			
" 27′-0″	8/1.12	9/1.11	9/1.22	10/1.19	12/1.10	12/1.17	15/1.03	15/1.13				
" 28′-0″	9/1.09	9/1.18	10/1.19	10/1.28	12/1.18	12/1.26	15/1.10	15/1.21				
" 29′-0″	9/1.17	10/1.16	10/1.28	12/1.17	12/1.27	15/1.09	15/1.18	15/1.30				
" 30′-0″	10/1.14	10/1.24	12/1.16	12/1.25	12/1.36	15/1.17	15/1.27					

"NATCOFLOR" LONG-SPAN SYSTEM



PERSPECTIVE VIEW "NATCOFLOR" TILE SYSTEM

ANOTHER type of one way combination system for which this company has developed a special tile is the "NATCOFLOR." This tile has been designed to obtain the maximum sectional area of the tile unit where it will be of the most use in resisting the compressive stresses ordinarily taken by the concrete top in the other forms of combination systems, and so designed as to keep down to a minimum the dead weight of the tile itself. Tests have repeatedly and clearly demonstrated that tile may be safely figured to take compressive stresses of 1,000 lb. per sq. in. of sectional area, allowing an ample factor of safety.

Cement grout mixed 1 part cement to 2½ parts sand, is used for the 2-in. wide joists, and flows readily around the steel reinforcing completely filling these joist spaces. Where the open ends of the tile are exposed next to girders, etc., and wherever necessary, they are closed with tile slabs or sheet metal, or as deemed desirable.

A few of the advantages of NATCOFLOR construction are as follows:—

NATCOFLOR construction costs less than the ordinary one-way combination systems for similar spans and loads.

Reduced thickness of floor slab.

Extremely light dead load.

Speed of erection due to the perfect alignment of the tile and small amount of materials required for reinforced joists.

All clay soffit under reinforced joists for fire protection.

All clay surface, properly scored for plastering, eliminating possibility of stains on plaster from exposed concrete joists.

For Table of Safe Loads—see next page.

"NATCOFLOR" LONG-SPAN SYSTEM

DATA FOR DESIGNING PURPOSES

The upper figures in table denote the depth of tile; the lower figures indicate the area of reinforcing steel required in each mortar rib. Thickness of floor=depth of tile.
The table below is so arranged that it can be used for floor slabs freely supported at both ends, semi-continuous, or continuous.
For slabs freely supported at both ends (simple span) use loads given opposite $\frac{WL}{8}$
For slabs freely supported at one end and continuous over other support, use loads given opposite $\frac{WL}{10}$.
For slabs continuous over both supports use loads given opposite $\frac{WL}{12}$.
For semi-continuous and continuous spans proper reinforcement must be provided in top of slab over support to take care of negative bending moment.
Shearing stress must be investigated in all cases

NO CEMENT TOP

fm & ft 1000 lb. per sq. in.
fs 16000 lb. per sq. in.

$\frac{Et}{Es} = \frac{1}{10}$

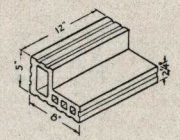
¾-in. below reinforcement
2-in. mortar ribs, 13-in. on centers

Bending Moment	TOTAL SAFE LOADS (Dead & Live)											
$\frac{WL}{12}$	150	165	180	195	210	225	240	260	300	335	375	450
$\frac{WL}{10}$	125	135	150	160	175	185	200	220	250	280	310	375
$\frac{WL}{8}$	100	110	120	130	140	150	160	175	200	225	250	300
Span 6′-0″	4/.16	4/.17	4/.19	4/.20	4/.22	4/.23	4/.25	4/.28	4/.31	4/.35	4/.39	5/.35
" 7′-0″	4/.21	4/.23	4/.26	4/.27	4/.30	4/.32	4/.34	4/.38	5/.32	5/.36	5/.40	5/.48
" 8′-0″	4/.28	4/.30	4/.33	4/.36	4/.39	5/.31	5/.33	5/.37	5/.42	5/.47	5/.52	6/.49
" 9′-0″	4/.35	4/.38	5/.32	5/.34	5/.37	5/.39	5/.42	5/.46	5/.53	6/.46	6/.51	6/.62
" 10′-0″	5/.33	5/.35	5/.39	5/.42	5/.46	5/.48	5/.52	6/.45	6/.51	6/.57	6/.63	7/.63
" 11′-0″	5/.39	5/.43	5/.47	5/.50	6/.43	6/.46	6/.49	6/.54	6/.62	7/.57	7/.63	8/.65
" 12′-0″	5/.47	5/.51	6/.44	6/.47	6/.51	6/.54	6/.59	6/.65	7/.61	7/.68	7/.75	8/.77
" 13′-0″	6/.43	6/.47	6/.52	6/.55	6/.60	6/.64	7/.57	7/.63	7/.71	8/.67	8/.75	9/.79
" 14′-0″	6/.50	6/.54	6/.60	6/.64	7/.58	7/.61	7/.66	7/.73	8/.70	8/.78	9/.75	9/.91
" 15′-0″	6/.57	6/.62	7/.57	7/.61	7/.67	7/.70	7/.76	8/.70	8/.80	9/.78	9/.86	10/.93
" 16′-0″	6/.65	7/.58	7/.65	7/.69	7/.76	8/.67	8/.73	8/.80	9/.79	9/.89	10/.87	12/.86
" 17′-0″	7/.61	7/.66	7/.73	8/.66	8/.72	8/.76	8/.82	9/.79	9/.90	10/.89	10/.99	12/.97
" 18′-0″	7/.68	7/.74	8/.69	8/.74	8/.81	9/.74	9/.80	9/.88	10/.89	10/1.00	12/.90	12/1.08
" 19′-0″	7/.76	8/.69	8/.77	8/.82	9/.78	9/.83	9/.89	10/.88	10/.99	12/.90	12/1.00	
" 20′-0″	8/.71	8/.77	8/.85	9/.79	9/.87	9/.92	10/.88	10/.97	12/.89	12/1.00	12/1.10	
" 21′-0″	8/.78	8/.85	9/.82	9/.88	10/.85	10/.90	10/.97	12/.87	12/.98	12/1.10		
" 22′-0″	9/.75	9/.81	9/.90	10/.85	10/.93	10/.99	12/.86	12/.95	12/1.08			
" 23′-0″	9/.82	9/.89	10/.87	10/.93	12/.83	12/.87	12/.94	12/1.04	12/1.18			
" 24′-0″	9/.89	10/.86	10/.95	12/.82	12/.90	12/.95	12/1.03	12/1.13				
" 25′-0″	10/.86	10/.93	12/.84	12/.89	12/.97	12/1.03	12/1.11					
" 26′-0″	10/.93	12/.81	12/.90	12/.96	12/1.05	12/1.12						
" 27′-0″	12/.81	12/.88	12/.97	12/1.04	12/1.13							
" 28′-0″	12/.87	12/.94	12/1.05	12/1.12								
" 29′-0″	12/.94	12/1.01	12/1.12	12/1.20								
" 30′-0″	12/1.00	12/1.08	12/1.20									

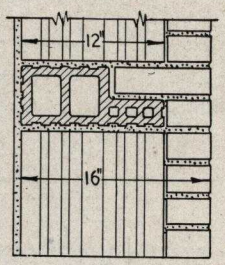
DESIGN DATA

Size	Cu. ft. Mortar per sq. ft.	Weight in lb. Each Tile	Weight in lb. Floor sq. ft.	Size	Cu. ft. Mortar per sq. ft.	Weight in lb. Each Tile	Weight in lb. Floor sq. ft.
4 in.	.051	26	28	8 in.	.102	34	45
5 in.	.064	28	34	9 in.	.115	37	48
6 in.	.077	30	39	10 in.	.128	40	52
7 in.	.090	32	42	12 in.	.154	47	59

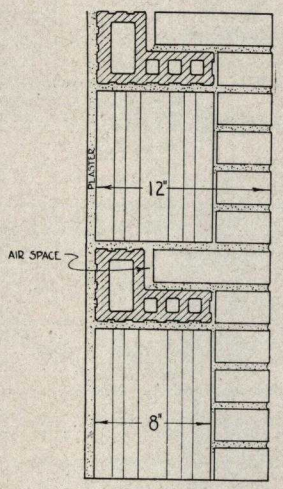
NATCO HEADER BACKER TILE



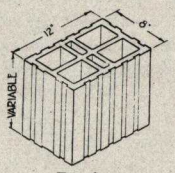
Header



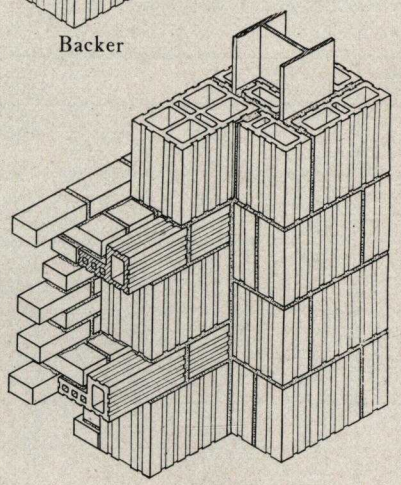
Section of 16 in. wall
(Wt. 111 lb. per sq. ft.)



Section of 12 in. wall
(Wt., 87 lb. per sq. ft.)



Backer



Bonding of column covering and wall

Note:—Natco Header Backer Tile are manufactured in 6, 8, 10 and 12 in. thickness for 10, 12, 14 and 16 in. walls, respectively. Combinations of these various stock sizes are easily made for walls of greater thickness.

Walls of Natco Header Backer Tile in combination with brick or stone, are mechanically bonded, light in weight, substantial and permanent. Their use in commercial and industrial buildings has become a standard construction.

For enclosure walls in steel or reinforced concrete skeleton buildings, Header Backer walls are the ideal of economy, while at the same time they retain the very desirable face brick or stone exterior. A saving of 25 per cent in labor and mortar is effected in the walls themselves, and a lighter structural frame, made possible by a 25 per cent reduction in dead weight, further decreases costs considerably.

The Natco Header is a tile designed especially for bonding the header courses of face brick to the tile backing. The Natco Backer is a rectangular tile for backing the stretcher courses of brick and is cut to various heights for proper bonding with different thicknesses of face brick and mortar joints. With the standard brick of 2¼ in. thickness, laid up with ½ in. bed joints, a Backer tile 10½ in. high is required and this is the most common usage.

One 8x5x12 header Tile and one 8x12x10½ Backer Tile, including ½ in. bed and vertical joints, lay up 1.43 sq. ft. of wall surface, or conversely, there are required 700 Headers and 700 Backers to lay up 1000 sq. ft. of wall surface.

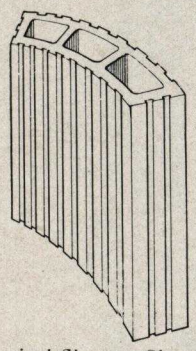
ADVANTAGES:

1. Ability to work to any story height without cutting or use of slabs.
2. Full bearing for floor joists.
3. Decreased dead loads compared to brick backing.
4. Made in suitable heights to afford proper bonding.
5. No through mortar joints—therefore no moisture penetration, eliminating necessity of furring.
6. Minimum number of units to handle.
7. Saving in mortar.
8. Rapidity of construction.

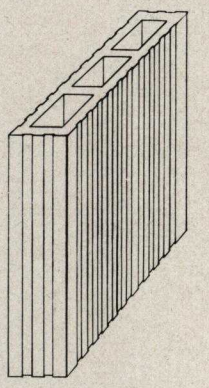
} Reduced cost of setting.

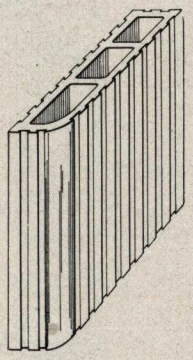
9. Ease of erecting pipe chases and cutting for conduit.
10. Simplicity of construction at jambs and corners and on walls of multiple thickness.

NATCO COLUMN COVERING

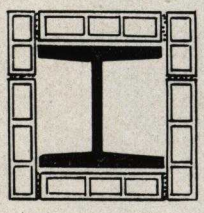


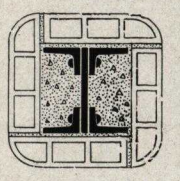
Typical Shape—Circular Column Covering

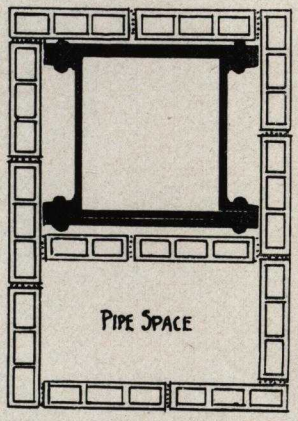


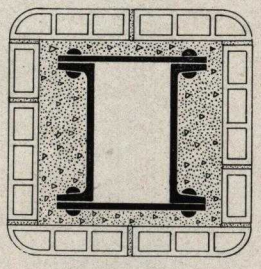


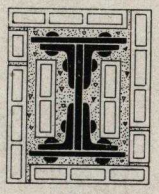
Typical Shapes—Square Column Covering



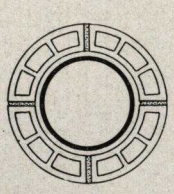


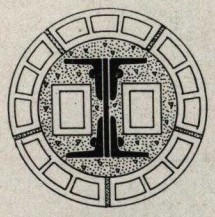






Typical Sections of Square Columns Hollow Tile Covering in Place





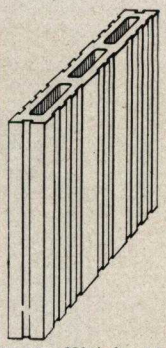
Typical Sections of Circular Columns—Tile Covering in Place

EXPERIENCE has demonstrated the necessity of thoroughly protecting cast-iron or steel columns supporting walls or floors, and that well-burned hollow tile is the most efficient material for this purpose. It should be at least 3 in. thick. Square columns are commonly encased in square coverings made of partition tile set breaking joints. Round corners can be furnished if absolutely necessary, see "Typical Sections" above.

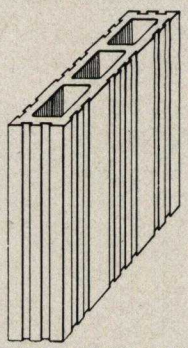
Any piping carried alongside of the columns should be provided for in a separate chase, built outside of the main column covering as shown in one of above sections.

A low rate of fire insurance can be secured only when the columns are properly protected, for the durability of the entire building is dependent upon the integrity of the columns. Particular attention should be given by the architect to see that the column covering is properly applied. The space between the hollow tile and the steel should be filled with concrete or cement mortar to prevent the possibility of corrosion and for additional security against fire.

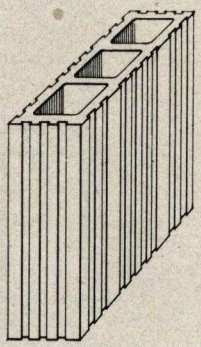
NATCO PARTITION TILE—Ohio Factories



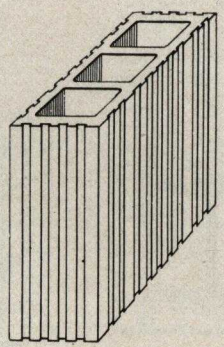
2x12x12—Weight 15 lb.



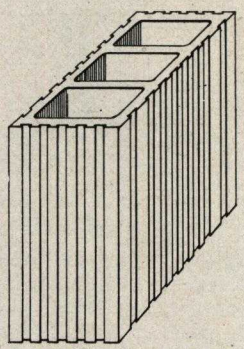
3x12x12—Weight 15 lb.



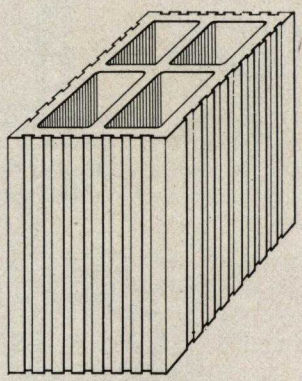
4x12x12—Weight 16 lb.



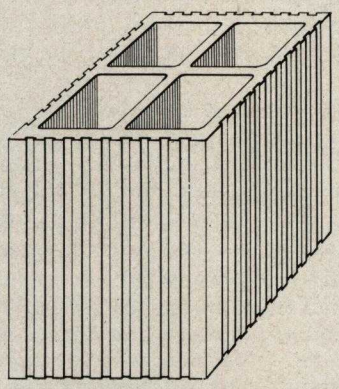
5x12x12—Weight 19 lb.



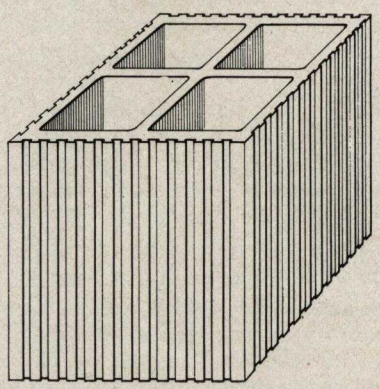
6x12x12—Weight 22 lb.



8x12x12—Weight 30 lb.



10x12x12—Weight 36 lb.

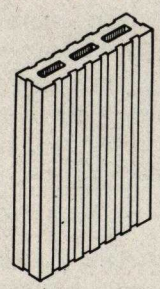


12x12x12—Weight 40 lb.

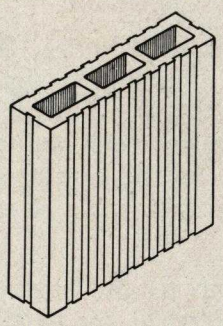
STANDARD SIZES AND APPROXIMATE WEIGHTS OF PARTITION TILE

Western factories make same shapes and sizes, except that their 8 in., 9 in., 10 in. and 12 in. tile are 6 cell.
Weights given for estimating purposes only—they vary at different factories.

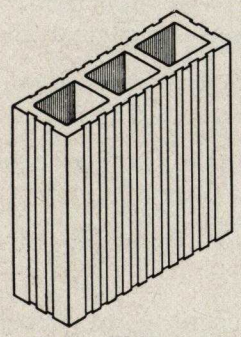
NATCO PARTITION TILE—Eastern Factories



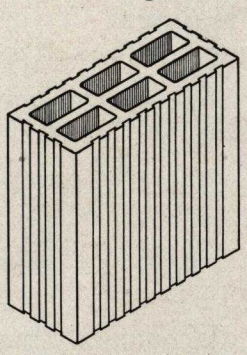
2x8x12—Weight 10 lb.



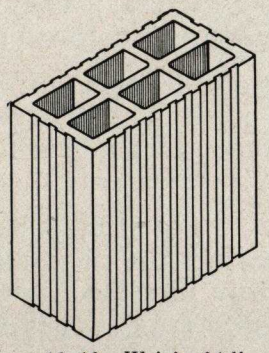
3x12x12—Weight 15 lb.



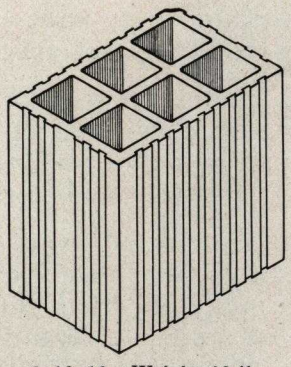
4x12x12—Weight 16 lb.



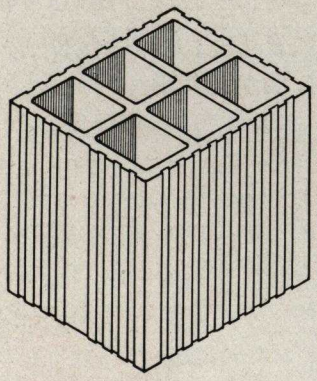
5x12x12—Weight 22 lb.



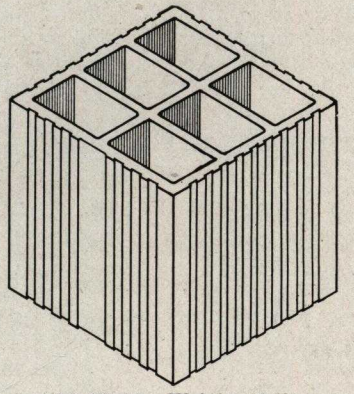
6x12x12—Weight 24 lb.



8x12x12—Weight 30 lb.



10x12x12—Weight 36 lb.



12x12x12—Weight 40 lb.

STANDARD SIZES AND APPROXIMATE WEIGHTS OF PARTITION TILE

Weights are given for estimating purposes only—they vary at different factories.

NATCO PARTITION TILE

THE fires in Baltimore, Rochester and San Francisco proved beyond the shadow of a doubt that hollow tile partitions are the only ones that will withstand a great conflagration. Where they were properly built upon the fireproof arches or steel beams, laid with cement mortar and wedged against the floor arches at the ceiling above, they stood intact, while all forms of plaster blocks crumbled into rows of rubbish and metal lath partitions twisted into scrap iron.

In addition to their fire-resisting qualities, hollow tile partitions are light, strong, easily erected by bricklayers, and do not transmit heat, cold or sound.

All partitions and furring tile, unless otherwise specified, are scored to receive plastering. If the surface is to be whitewashed the tile can be made smooth.

Wood or channel-iron bucks are placed in all door openings, and should be 1½ in. wider than thickness of the tile and act as grounds for the plastering.

It is not generally practicable to use 2-in. tile for partitions, except for closets, shafts, etc.

Three-in. partition can be safely used up to 12 ft. in height, 4-in. to 16 ft. and 6-in. to 20 ft.

The tile are commonly made 12 in. wide by 12 in. long, except 2-in. tile at eastern and northeastern factories, which is made 12 in. long but 8 in. wide at eastern factories and 6 in. wide at the northeastern factory. They can be made made any size required, but special sizes are necessarily more expensive.

In office buildings it is good practice to have all the main corridor and stairway and elevator enclosures of 4-in. and the partitions between rooms 3-in. Partitions should be bonded where meeting and anchored to wood bucks or brick walls by using tenpenny nails, or metal wall ties, in each second joint.

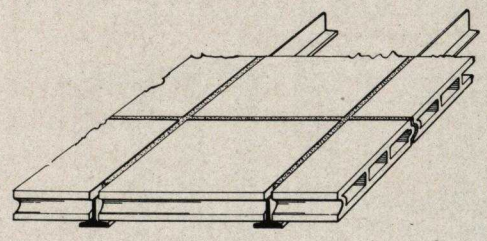
Tile should be set on end, except top course, which may be set on side. When required for outside walls exposed to the weather the tile must be specially made of dense material, hard burned. At a slightly increased cost they can be made smooth on outside face and do not require plastering. They should be not less than 6 in. thick.

NATCO LOAD BEARING PARTITIONS AND PENT HOUSE WALLS

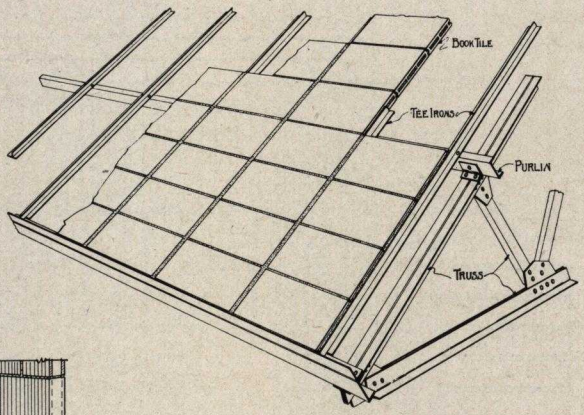
For partitions carrying heavy loads, we manufacture the Natco XXX Load Bearing Tile in the various sizes in which Natco Partition Tile are furnished. Natco XXX Tile with its greater strength, due to the increased thickness of the webs and shells, is also recommended for walls where the height is excessive.

Natco XXX Load Bearing Tile are also especially suitable for the construction of Pent Houses since they have the heavier scoring in addition to making much more sturdy walls.

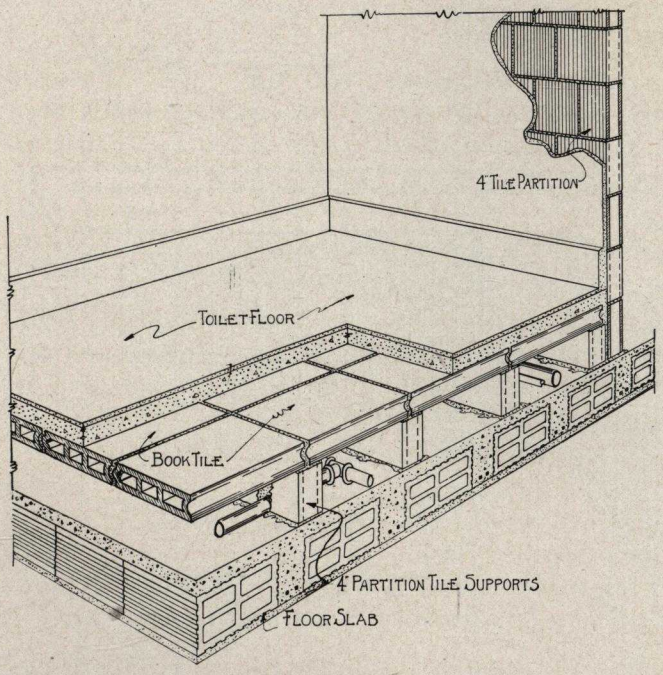
NATCO BOOK TILE



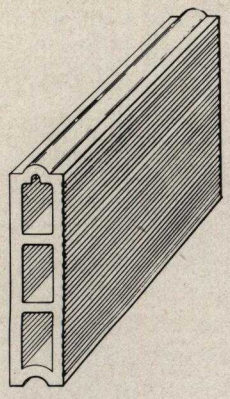
Perspective—Book Tile Roof Detail



Perspective View—Book Tile in place on Structural Steel Roof Construction



Perspective View—Toilet Room Floors showing 4-inch Partition Tile supporting Book Tile Floor



Standard Book Tile
Square-cut Ends

ON account of their shape these tile are called "Book Tile," and they are made especially for roofs to be covered with concrete, tar and felt or any composition roofing. They are made of uniformly hard-burned material 3 in. thick, and of a length depending very much upon the weight to be carried.

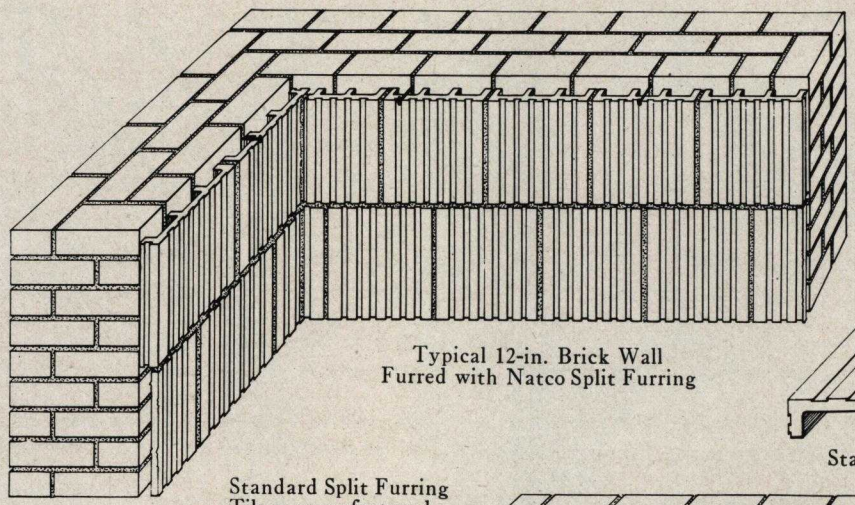
Specifications for the steel frame work should call for the spacing of T's to be 1 in. wider than the length of the tile; for example, for tile 18 in. long the T-irons should be spaced 19 in. on centers.

Book tile are used for covering the flat roofs of pent houses, bulkheads, etc., and may be used for the main flat roof of a building when only light live loads are anticipated. If heavy live loads are expected, use Natco Flat Arches on I-Beams or "Combination" Long Span Construction.

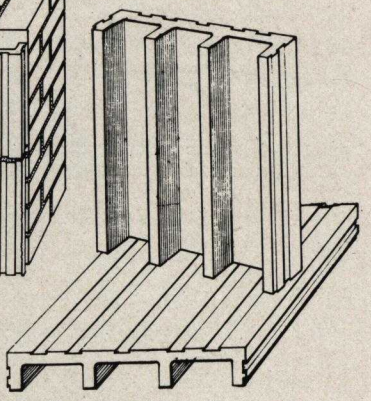
When providing for future increase in height of a building, a floor of flat arches is set and roof grading placed on temporary supports of T's, (or dwarf–walls), and book tile.

Years of experience have shown that Natco Book Tile roofs are not affected by acids which makes this type of roof particularly suited for glass factories and other types of roofs liable to be attacked by acid or other injurious fumes.

NATCO WALL FURRING

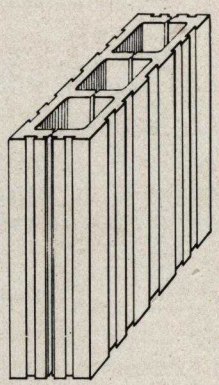


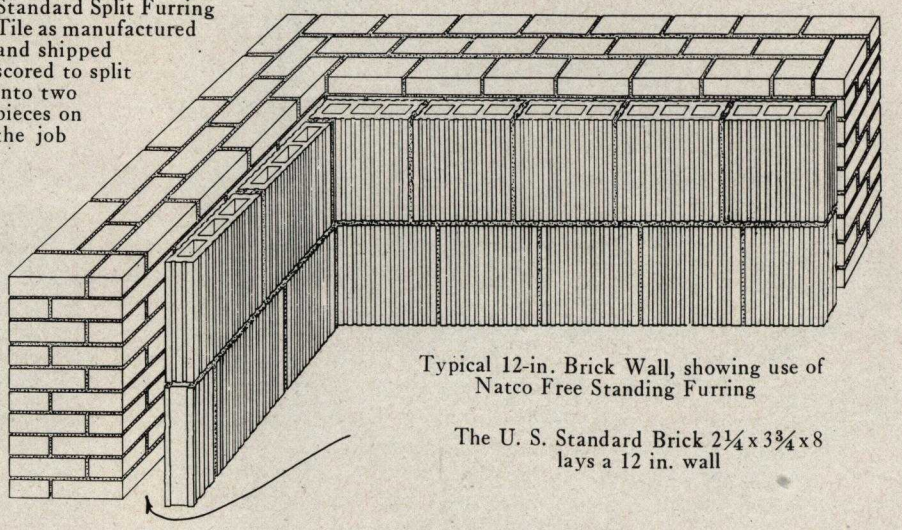
Typical 12-in. Brick Wall
Furred with Natco Split Furring



Standard Split Furring Tile

Standard Split Furring Tile as manufactured and shipped scored to split into two pieces on the job





Typical 12-in. Brick Wall, showing use of Natco Free Standing Furring

The U. S. Standard Brick 2¼ x 3¾ x 8 lays a 12 in. wall

BRICK walls exposed to the weather must be furred with hard burned tile as shown above, to prevent dampness reaching the interior and destroying the plastering and interior decorations.

The tile are made either 1½ or 2 in. thick and 12 in. square. The ribs being set against the wall, an air space is formed which effectively checks the passage of moisture. They should be set with the ribs vertical and fastened to the wall by driving tenpenny nails in the joints of the brickwork, the head of the nail being bent down upon the tile, using a nail over every third tile in every second course; or metal wall ties may be imbedded in wall, as provided by local building codes. The tile should not be bedded in mortar at the back since this would defeat their purpose by making a solid connection to transmit moisture.

Where walls must be straightened or furred out to line with the face of piers the 2-in. tile cannot be used. If the ceiling height is not too great use 3-in. partition tile. If the space is greater than 3 in. the tile may be set out from the wall leaving a clear air space behind them. They should be braced at intervals by the use of drive anchors or 4-in. tile can be used without the anchors. This is known as free standing furring.

The face of the tile is grooved so that the plastering is applied directly upon the tile.

This form of furring is the most effective, the most economical and most durable.

If any form of metal lath furring is used against exposed walls it will be destroyed by rusting in a few years, and its renewal will be very costly, especially where walls are decorated.

SPECIFICATIONS FOR STANDARD HOLLOW TILE FIREPROOFING

Local building codes vary and specifications should be written to agree.

GENERAL	The contractor for this work will be required to furnish all the material and labor of every description required to erect the same in place complete. The contractor is referred to the plans and details for the general construction, and especially the steel diagrams and details showing connection between the structural steel and tile work.
DETAILS	When requested to do so the contractor shall furnish large scale details or full-size drawings for all special shapes, column coverings, lintel covers, girder covers, and general type of arch; which shall be submitted to the architects for their approval.
SPECIAL SHAPES	The contractor shall furnish all necessary special shapes for the proper fitting to the steel work.
SCAFFOLDING, TOOLS, ETC.	Furnish all the tools, machinery, hoisting apparatus and centering necessary to carry on the work at the rate of progress stipulated in the contract.
TILE	All the tile required for this work shall be of the best quality of uniformly hard-burned hollow tile. This tile to be well manufactured. No badly split, cracked or warped tile will be permitted to go into the work. Material to be Natco hollow tile manufactured by the National Fire Proofing Company or approved equal.
MORTAR AND LAYING	All tile work shall be laid in mortar composed of 1 part of Portland cement and ⅓ part of hydrated lime or lime putty to 4 parts of sand. Lime putty shall be made from freshly burned lime thoroughly slaked. Mortar having taken its initial set shall not be used; retempering will not be permitted. Fill all joints between tile and steel with mortar.
TYPE OF ARCH	The arches for the floors in general shall be.....in. flat (or segmental arch) construction. Skewbacks must be carefully bedded in place against beams.
BEAM TILE	The soffits of all beams shall be protected with soffit tile at least 1½ in. in thickness.
ROOFS	The arches for the main roof are to be.....in. flat (or segmental) arch construction same as specified for the floors.

MINOR ROOFS

The roofs of pent houses, roof over projecting portion in second story, floors of bulkheads, and other portions indicated on details as book tile shall be made of 3-in. book tile set in place between tee-irons.

Tees are to be furnished by the contractor for steel-work.

PARTITIONS

All partitions must start on steel beams or on fireproof floor arches.

Partitions shown on the plans are to be built the thickness indicated in figures. If no dimensions are given, the following sizes will govern:

Partitions for all corridors and for partitions over 12 ft. and up to 16 ft. in height, are to be 4 in.

Partitions over 16 ft. in height shall be 5 or 6 in. and all cross partitions, 12 ft. or less, are to be 3 in. Partition walls shall be built straight, true, plumb and well bonded with proper "break-joint" bond on each alternate course, and all joints are to be thoroughly flushed up with mortar, and to be well wedged underneath fireproof ceiling.

FURRING TILE

Where indicated on plans, 2-in. furring tile are to be built against the outside walls of the building. These tile are to be secured to the brick walls with tenpenny spikes on every second course, driven into the brick work at intervals not greater than 36 in. horizontally; or metal wall ties anchored into brickwork may be used.

CURB WALL

The curb wall in basement shall be furred with 3-in. tile extending up to the under side of the iron plate along edge of curb wall and properly fitting around all beams.

ROUGH FRAMES

The contractor for carpenter work will furnish and erect the rough wood frames at all openings in partitions and furring.

COLUMN COVERING

All column covering shall start directly from the tile floor arches.

Column covering shall be designed to properly fit the columns. All corners of square columns shall be left (square) (round).

Column covering to be wired (once) (twice) in each course in height or secured together with clamps. Tiles must be set to break joints.

NAILING BLOCKS

Furnish and set where required for nailing trim, wood blocks well bedded in cement mortar.

COVERING EXPOSED STEEL WORK

All girders, beams, channels, etc., that show below the under side of ceiling are to be incased on all sides with at least $1\frac{1}{2}$ in. thickness of fireproof tile secured to the steel in the usual manner. If required, special designs must be submitted to the architect.

BOXES FOR PLUMBING PIPES

All soil, vent, down-spout and water supply pipes shall be boxed in, using 3-in. tile, starting from the floor tile in all cases. This boxing shall not be done until the pipes have been properly tested, and covered by another contractor. There shall be no openings into boxes except for outlets on the various floors. Where these outlets occur small wood frames furnished by carpenter shall be set by the fireproofing contractor.

BULKHEADS

All bulkheads shown on plans shall be built of 4-in. tile; the structural iron contractor furnishing all necessary tees for the support of the tile.

See details for bulkhead treatment, and steel drawings for the supports.

Provide 4-in. tile for the end of bulkhead where intersected by the entrance doors.

TOILET-ROOM FLOORS

All toilet-room floors, where shown on plans, shall be raised approximately ..... in. with fireproofing supports to be so arranged as to not interfere with the piping of these rooms.

PENT HOUSES

The contractor shall build the walls of pent houses with Load Bearing Tile, laid up in portland cement mortar, all joints to be thoroughly flushed.

Curbs of all skylights shall be built of 4-in. tile.

WOOD FLOOR SLEEPERS AND CONCRETE FILLING

After the floor arches have been set in place, and at such times as may be designated by the architect, the contractor for carpenter work will furnish and set the 2-in. by 3-in. wood sleepers required for nailing the finished wood flooring, where wood floors are called for.

After the strips have been set, the fireproofing contractor must fill in between the same with concrete filling; this concrete is to be composed of 1 part American portland cement, of approved brand, to 10 parts broken tile, stone, gravel, or fine, clean coal cinders, thoroughly mixed together dry, then tempered and mixed, and tamped in place. In no case shall cinder concrete be allowed to come in contact with structural steel, pipes, conduits, or other steel parts.

FINALLY

Do everything necessary to finish the entire work in a thorough and substantial manner.

Remove promptly from the premises all the tools, scaffolding, unused tile, debris, etc., as soon as the work is completed.

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